

Current Science

Vol. 27, No. 4

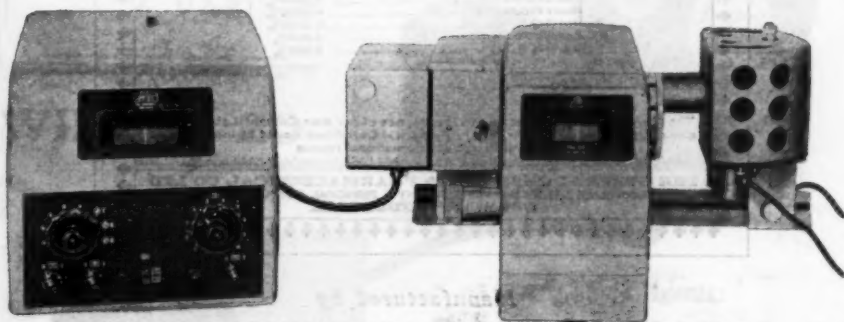
APRIL 1958

Pages 117-154



SPECTROPHOTOMETER

Mains-operated Model PMQ II



Made by Carl Zeiss, Oberkochen, Germany.

For precise measurements from 200 $m\mu$ in the ultraviolet to 1000 $m\mu$ in the near infrared region with high spectral resolution. Write for illustrated literature.

Sole Agents

ADAIR, DUTT & CO. (India) Private LTD.

CALCUTTA MADRAS SECUNDERABAD BOMBAY NEW DELHI

RESEARCH FINDINGS MUST BE POSITIVE NOT
HYPOTHETICAL

and you ensure this by using

“JUDACTAN” W.A.B.A. CHEMICALS

Explanation:

JUDACTAN is the manufacturer's trade mark for A.R. Quality
Reagents with Actual Batch Analysis as per facsimile shown below

JUDACTAN	
JUDEX ANALYTICAL REAGENT	
HYDROCHLORIC ACID A.R.	
HC1	Mol. Wt. 36.465
ACTUAL BATCH ANALYSIS (Not merely maximum impurity values)	
Batch No. 48001	
Arsenic (As ₂ O ₃)	0.00001%
Free Chlorine (Cl)	0.00001%
Heavy Metals (Pb)	0.00005%
Iron (Fe)	0.00003%
Residue after Ignition	0.0014%
Sulphate (SO ₄)	0.0001%
The above analysis is based on the results, not of our own Control Laboratories alone, but also on the confirmatory Analytical Certificate issued by independent Consultants of international repute	
THE GENERAL CHEMICAL & PHARMACEUTICAL CO LTD CONTRACTORS TO HM GOVERNMENT & PRINCIPAL CORPORATIONS SUDBURY MIDDLESEX	

Manufactured by

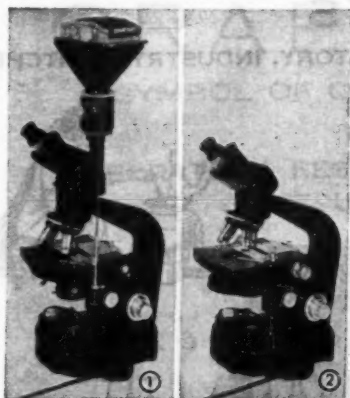
THE GENERAL CHEMICAL & PHARMACEUTICAL CO. LTD.
SUDBURY, ENGLAND

Please write for stock list to
SOLE AGENTS

MARTIN & HARRIS (Private) LTD.

(SCIENTIFIC DEPARTMENT)

SAVOY CHAMBERS, WALLACE STREET, BOMBAY 1

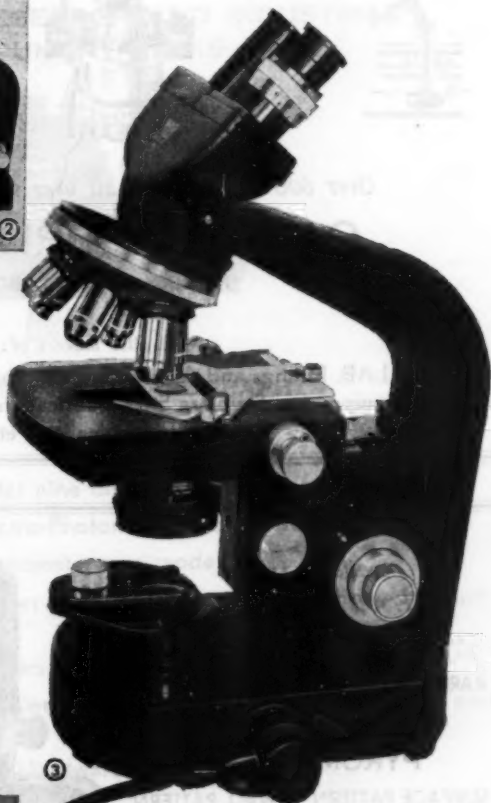


WILD
HEERBRUGG

* The most COMPLETE
Microscope so far
made

* Ideal for QUALITY
PRECISION
& VARIETY

WILD M 20



The M 20 Microscope with few of its attachments.

Fig. 1: With Micro Camera and Binocular Tube;

Fig. 2: Equipped as Phase Contrast Microscope;

Fig. 3: With Six-Hole Nosepiece; Filter Exchanger,
etc.;

Fig. 4: Built-in Illuminator for Kohler Illumination.

Sole Agents:

RAJ-DER-KAR & CO.

COMMISSARIATE BUILDING, HORNBY ROAD
BOMBAY-1

Telephone: 26-2304

Telegram: TECHLAB

Our Sub-Agents:

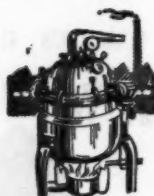
VULCAN TRADING Co., (P) LTD.

38-C Mount Road
MADRAS-6



GAS PLANTS

FOR LABORATORY, INDUSTRY & KITCHEN



Over 600 Installations all over the Country & Abroad.

GANSONS (PRIVATE) LTD.

Post Box No. 5576, BOMBAY 14

Also makers of :

Superior LAB. Fittings and Accessories, e.g., Burners, Stills, Baths, Ovens, Nuclear Physics Equipments, Stainless Steel Fabrications for Pharmaceutical & Chemical Industries, etc., etc.

'Available from
READY STOCK

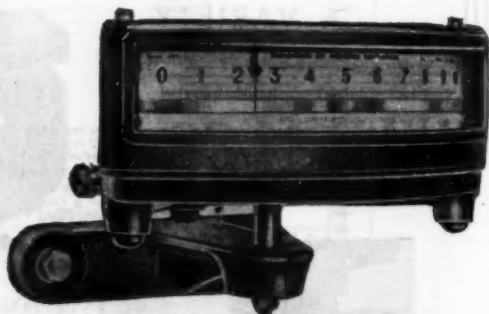
THERMOCOUPLES

* RARE & BASE METAL * ANGLE TYPE
FOR SALT BATH FURNACE

PYROMETERS

* SURFACE PATTERN * WALL PATTERN
* BENCH MODEL * OPTICAL

INDICATORS & COMPENSATING CABLES



For further details please contact :

LABORATORY FURNISHERS

DHUN MANSION, VINCENT ROAD, DADAR, BOMBAY 14

PHONE: 62761

Branch: AHMEDABAD

CRAFTSMAN

A SYMBOL OF QUALITY AND SERVICE

—FOR—

LABORATORY, RESEARCH AND INDUSTRIAL
INSTRUMENTATIONS



POT-TITRATION & POLAROGRAPH

We assemble:

- * Photoelectric Colorimeter nine different models.
- * Photoelectric Filter Spectro-Photometers four models.
- * Photoelectric Flame Photometer one model.
- * Polarograph, Karl Fischer and Potentiometric Titration Unit with Automatic Burettes.
- * Thermocouples, Pyrometers and Controllers.
- * Thermostats, Relays, Water and Oil Baths, Incubators, Ovens and Furnaces.
- * Laboratory Utility Items, Hardware and Shakers.

We Stock:

Cambridge pH-meter, Pyrometers and Thermocouples.



ASK FOR DETAILED INDEX:

CRAFTSMAN ELECTRONIC CORPN. (PRIVATE) LTD.

Laboratory, Factory & Office

SETHNA HALL, NESEIT ROAD, MAZAGAON, BOMBAY 10

Phone : 42346

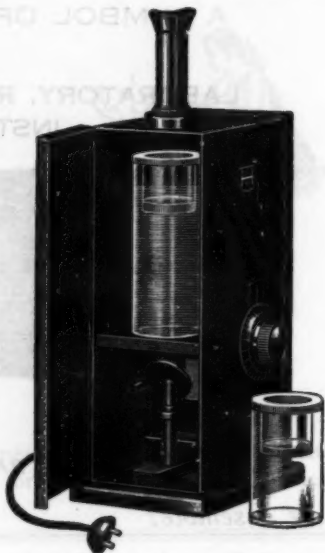
HELLIGE INC., U.S.A.

Apparatus for

TURBIDITY MEASUREMENTS, SULPHATE DETERMINATIONS AND SPECIAL APPLICATIONS

Modern in design and operating principle, the Hellige Turbidimeter does not require standard suspensions or long cumbersome tubes. Accurate readings can be made rapidly by those without technical training.

Precise determinations are performed in the ranges of 0 to 150 p.p.m. SiO_2 and 0 to 100 p.p.m. SO_4 . Higher values are determined by diluting the specimen.



PH CONTROL AND WATER TESTS

Pocket and Standard Comparator with prismatic attachment.

Exclusive features—Permanent reliability of
NON-FADING GLASS COLOUR STANDARDS
and accuracy of colour comparison.

GORDHANDAS DESAI (PRIVATE) LTD.

SIR PHEROZSHAH MEHTA ROAD, BOMBAY 1

P-7, Mission Row
Extension
CALCUTTA 1

4/2 B, Asaf Ali
Road
NEW DELHI

22, Lingbi Chetty
Street
MADRAS 1

WHATMAN

will be showing
some important new materials
at the 12th ACHEMA Exhibition

★ **GLASS FIBRE PAPERS**

for filtration, Chromatography and Electrophoresis

★ **ION EXCHANGE CELLULOSES**

for paper and column separations

★ **SPECIAL CHROMATOGRAPHY PAPERS**

including "purified" and "reversed phase" papers

In addition there will be the

complete range of Whatman Filter Papers

for Routine Chromatography and Filtration

on **STAND D2, HALL 6**

—the stand of

W. & R. Bilston Ltd. (Whatman)

TEMPO LABORATORY EQUIPMENT



HOT AIR OVEN

**TEMPO INDUSTRIAL CORPORATION
(PRIVATE) LTD.**

Sonari Road, Paranjpe 'B' Scheme, BOMBAY-24

—RELIABLE HOUSE FOR—

- ❖ LABORATORY GLASSWARES
(Plain and Graduated)
- ❖ THERMOMETERS & HYDROMETERS
(Various ranges)
- ❖ LABORATORY PORCELAINWARES &
SILICAWARES
- ❖ NICKEL AND PLATINUMWARES
- ❖ WHATMAN FILTER PAPERS
- ❖ MICROSCOPES & ACCESSORIES
- ❖ BALANCES, TINTOMETERS, AEROGEN
GAS PLANTS AND OTHER INSTRU-
MENTS REQUIRED BY CHEMICAL
LABORATORIES

Contact:

UNIQUE TRADING CORPN.
221, Sheriff Devji Street
BOMBAY 3

Gram: 'UNILAB'

Phone: 30011

For
**ZOOLOGICAL SPECIMENS
AND
BIOLOGICAL REQUIREMENTS
OF THE
LABORATORIES
AND
INSTITUTIONS**

Consult:

Bombay Biological House

Dealers in Zoological Specimens

119, Hindu Colony, Dadar, Bombay 14

Established 1941

Phone: 61813

Gram: PHERETIMA

BOROSIL LABORATORY GLASSWARE

such as

FLASKS, BEAKERS, CONDENSERS,
MEASURING FLASKS, MEASURING
CYLINDERS, PIPETTES & ANY
SPECIAL APPARATUS MADE TO
DESIGN

and

PENICILLIN VIALS, VACCINE BULBS—
WHITE & AMBER



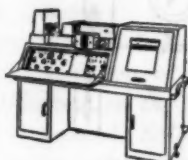
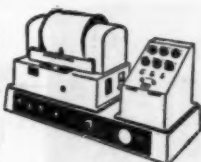
ALL OTHER APPARATUS & EQUIPMENT
MANUFACTURED TO CLIENT'S DESIGN

**INDUSTRIAL & ENGINEERING
APPARATUS CO. (PRIVATE) LTD.**

CHOTANI ESTATES, PROCTOR ROAD
GRANT ROAD, BOMBAY 7

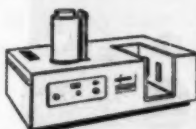
ANALYTICAL INSTRUMENTS by Perkin-Elmer

**MODEL 21
DOUBLE BEAM
RECORDING INFRARED
SPECTROPHOTOMETER**
The standard instrument
for infrared analysis.



**MODEL 13-U UNIVERSAL
SPECTROPHOTOMETER**
A highly flexible instrument
covering complete ultraviolet,
visible and infrared regions.

**MODEL 137 INFRACORD
DOUBLE BEAM
SPECTROPHOTOMETER**
A new instrument for
routine infrared analysis.

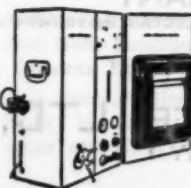
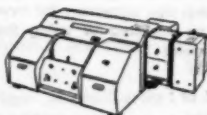


**MODEL 38-A
ELECTROPHORESIS
APPARATUS**
For analysis and separation
of complex solutions.



**MODEL 146 FLAME
PHOTOMETER**
For rapid analysis of any
element in solution
with visible emission lines.

**SPECTRACORD
MODEL 4000 RECORDING
SPECTROPHOTOMETER**
For ultraviolet, visual, near
infrared regions. Features
double monochromator.



**MODEL 154-B VAPOR
FRACTOMETER**
A new, low cost gas
chromatography apparatus
for analysis of gases and
liquids boiling upto 300°C.



Perkin-Elmer is proud to present a complete line of analytical instruments for the spectroscopic or chemical laboratory. Each embodies the most recent technical advances in its particular field—each is constructed with Perkin-Elmer's characteristically high standard of quality and workmanship, and each is backed with a complete set of accessories to make it useful for the widest possible range of problems.

The variety of instruments now available from Perkin-Elmer permits the equipping of a laboratory for practically all types of analyses with instruments of a single manufacturer. This can result in considerable savings in servicing, and in inventories of accessories.

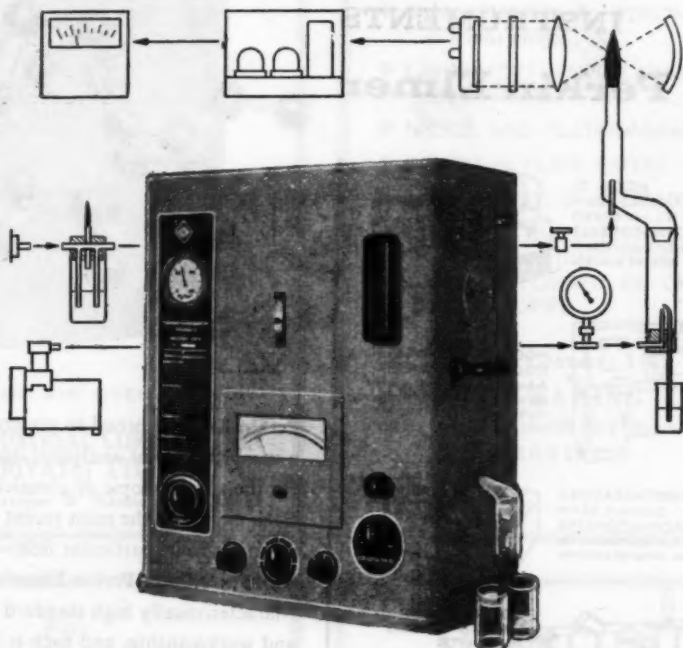
Sold and serviced in India exclusively by

BLUE STAR

BLUE STAR ENGINEERING CO. (Bombay) PRIVATE LTD.
BOMBAY • CALCUTTA • DELHI • MADRAS
Main Office: Kasturi Buildings, Jamshedji Tata Road, Bombay 1

PSBS-72 A

QUALITY CHEMISTRY LABORATORY APPARATUS & INSTRUMENTS



Dr. B. LANGE'S FLAME PHOTOMETER MODEL V

For determination of alkali, alkaline earth metals, etc. Recent advances in Flame Photometry make this an indispensable instrument in almost every branch of Science and Industry.

Advantages:

- * Has built-in compressor.
- * Works on city gas or petroleum cracked gases.
- * Constant voltage transformer keeping the output of compressor constant and gas pressure regulator ensure steady flame and accurate results.
- * A Lithium compensation accessory for overcoming interference is also available.
- * Special Accessories can be supplied for using the instrument as an absorptiometer.

A product of:

MESSRS. DR. B. LANGE, GERMANY

MANUFACTURERS OF COLORIMETERS, POLAROGRAPHS AND OTHER PHOTOELECTRIC INSTRUMENTS

SOLE AGENTS IN INDIA:

TOSHNIWAL BROS. (PRIVATE) LTD.

198, JAMSHEDJI TATA ROAD, BOMBAY 1

BRANCHES:

14 B/4 N.E.A.
NEW DELHI 5

9 BLACKER'S ROAD
MADRAS 2

16/1 A KEYATOLLA LANE
CALCUTTA 29

Current Science



Vol. XXVII]

APRIL 1958

[No. 4

CONTENTS

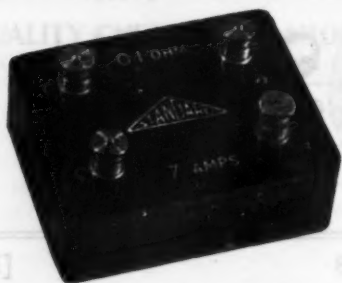
	PAGE
<i>The Quantum Hyper-Frequency Amplifier—The Maser—A. JAYARAMAN</i>	117
<i>Max Planck</i>	121
<i>New Type of Reflexes</i>	122
<i>The Chemistry of Nucleic Acids—T. R. SESHADRI</i>	123
<i>Symposium on the Monsoons of the World—P. R. P.</i>	129
<i>A Remarkable Solar Radio Event</i>	129
<i>Obituary: Professor M. Damodaran—K. RAMAMURTI</i>	130
<i>The Properties of Thrombinogen</i>	130

Letters to the Editor

<i>An Empirical Formula for the Masses of the Elementary Particles—LEONARD S. LEVITT</i>	131	<i>Stegana lateralis V.D. Wulp as a Pest of Sesbania grandiflora—T. R. SUBRAMANIAN AND K. R. NAGARAJA RAO</i>	138
<i>Determination of Blood Meals of Indian Culicoides (Ceratopogonidae: Diptera)—P. SEN AND S. K. DAS GUPTA</i>	132	<i>On the Antheridium in Characeae—V. S. SUNDARALINGAM AND K. J. FRANCIS</i>	138
<i>Apparent Molar Volumes and Aggregation of Barbiturates—V. R. KRISHNAN</i>	132	<i>Chromosome Numbers of Some Dicotyledons—R. P. PATIL</i>	140
<i>Presence of Propolis in the Prothoracic Spiracles of Apis florea Fab.—G. T. TONAPI</i>	133	<i>Lateral Bud Development in 'Pearl Millet'—Pennisetum typhoides Stapf et Hubbard, in Relation to Its Flowering—K. K. NANDA AND J. J. CHINYOY</i>	141
<i>The Regulation of Petal Number—SUBODH KUMAR ROY</i>	134	<i>The Study of Seed Content and Fruit Shape in Relation to Removal of Stigma in Luffa Species—S. N. SINGH</i>	143
<i>Periodicity of Wuchereria Microfilariae in Human Blood—P. SEN</i>	135	<i>Primitive Features in the Alimentary Canal of Gadusia chapra (Hamilton)—P. N. SRIVASTAVA</i>	144
<i>On Sal Wood Excavated from Mauryan Pillared Hall, Pataliputra—S. S. GHOSH AND KRISHNA LAL</i>	136	<i>Roots on an Internode in Sugarcane—T. A. DAVIS</i>	145
<i>Xyleborus discolor Bland., as a Pest of Cacao—I. P. JANAKI, T. S. MUTHUKRISHNAN AND K. R. NAGARAJA RAO</i>	138	<i>Cytology of Diplaziopsis javanica—S. S. BIR</i>	146

Reviews .. 147

Science Notes and News .. 153



CALIBRATED SHUNTS

For Potentiometer Work

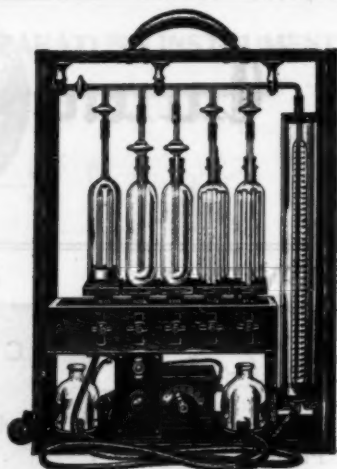
ACCURACY 0.1 PER CENT.
WOUND OF MINALPHA WIRE
WITH

CURRENT & POTENTIAL TERMINALS

Made by:

**THE STANDARD SCIENTIFIC
INSTRUMENTS Co.**

115, BRODIES ROAD, MADRAS 28



Associated Scientific Corporation

Manufacturers and Dealers in
SCIENTIFIC GLASS APPARATUS AND
EQUIPMENTS

232 B. UPPER CIRCULAR ROAD
CALCUTTA-4

GRAM : ASCINCORP

AVAIL. OF OUR EXPERT SERVICES

In servicing, repairing and designing your Electrical and
Electronic Equipment such as :

pH Meters, Photometers, Conductivity Bridges,
Cardiographs, H.F. Equipment, Diathermy
Units, Induction Heating Devices, etc., etc.

We have been doing this for various Firms and Government
Departments for over 15 years past

A TRIAL WILL SATISFY YOU

RADIO ELECTRIC LTD.

2B, LAMINGTON CHAMBERS, LAMINGTON ROAD

BOMBAY 4

THE QUANTUM HYPER-FREQUENCY AMPLIFIER—THE MASER

MICROWAVE electronics is full of novel features and is a fascinating field which in the last decade has made great headway.

The techniques for generation, amplification and transmission at microwave frequencies have had to depart from the methods of radio frequency electronics, in order to overcome certain functional limitations of tubes and transmission lines, commonly employed at lower frequencies. When one is considering propagation in a waveguide, the ordinary two wire line transmission ideas and the concept of current and voltage can no more be visualised in them. The behaviour can only be understood in terms of electromagnetic wave equations.

Similarly, tubes generating microwaves function on a new principle known as velocity modulation in which the electron beam interacts with a tunable cavity or cavities, experiencing in their passage through the tube column, a velocity change, depending upon the sign and magnitude of the exciting alternating voltage. The result is usually a bunching up of electrons with respect to time, and such bunched electrons when they interact with the cavity, transfer energy to it in the form of electromagnetic radiation. The travelling wave tube which is used as an amplifier in the microwave region makes use of a distributed interaction between an electron beam and a travelling wave.

While all the electrical amplifiers in use today, including the above, employ the motion of charged particles in electric or magnetic fields, very recently a totally different method has been discovered for amplifying electrical signals at microwave frequencies. The amplification is achieved by stimulated emission of radiation under suitable circumstances. The device which uses this principle is called a *maser*, the word having been coined from the words *micro-wave amplification by stimulated emission of radiation*.

The maser principle was suggested by Weber in 1953 and again independently by Barrow and Prokhorov in 1954. The idea was used in a microwave spectrometer by Gordon, Zeiger and Townes in 1954. In the last few years a large number of papers have been published on the subject analysing the theory and proposing new ways of incorporating the idea into practical devices.

THE PRINCIPLE OF MASER OPERATION

Energy transitions associated with atoms and molecules are restricted to only a set of "stationary states", each of which is characterised by a definite amount of internal energy. In free atoms and molecules, and also sometimes in atoms in a solid, the energy levels are sharp and transitions between them can be induced by electromagnetic radiation of appropriate frequency. If two levels between which transitions take place have energies W_A and W_B , the frequency given to the radiation field or taken from it is given by $\nu_{AB} = W_B - W_A/h$ where h is the Planck's constant.

From quantum mechanical grounds we have, that such transitions are likely, only when the frequency of the radiation that is interacting with the system is nearly equal to ν_{AB} . When the electromagnetic radiation induces a transition in which the atom gains energy, this energy is taken from the electromagnetic wave. Likewise, when the radiation induces a transition in which the atom loses energy, this is added to the electromagnetic wave. This addition is in the form of one photon of frequency ν_{AB} that is coherent with the exciting wave (has the same phase, direction and polarization).

A very general thermodynamic argument due to Einstein proves that the probability, that the radiation will induce an atom that is in state A to go into state B is equal to the probability that the same radiation will induce the reverse transition, that is from state B to state A. When matter is in thermal equilibrium the number of species in the i th state is proportional to $e^{-W_i/kT}$, where W_i is the energy of the i th state, k is the Boltzmann constant and T is the absolute temperature. If the state B has higher energy than state A, the ratio of the number of species in the two states will be

$$\frac{N_B}{N_A} = e^{-h\nu_{AB}/kT}$$

If the atoms are in thermal equilibrium at any temperature T , there are more atoms in the lower state than in the higher state and therefore, more transitions upwards take place than in the reverse direction. This would result in a net absorption of energy from the radiation. If, however, by some means we can get more atoms or molecules in the higher energy state than in the lower, there will be a net transfer of energy to the radiation field

which would result in power being added to the electromagnetic wave. This would result in amplification, and is the principle of operation of the maser amplifier.

Thus, for a maser to function as an amplifier at a given frequency, a working substance, namely, an atom or molecule, with energy levels having the requisite separation and between which the probability of induced transition is sufficiently large should be chosen. A suitable method should also be found to collect more atoms in the upper state than the lower. Finally, it is necessary to devise a technique for the radiation to interact with the working substance. A number of ingenious masers have been built and operated but all of them in the microwave region.

MASER EMPLOYING AMMONIA MOLECULE

The configuration of the ammonia molecule is a triangular pyramid with the nitrogen at the top of the pyramid. Two configurations are shown in Fig. 1 and these have different energies, one representing the ground level and the other lying at an energy level slightly above. Transition between these levels can take place and this is known as 'Ammonia inversion' discovered by Cleeton and Williams in 1937. The frequency of this transmission is in the microwave region at 24,000 Mcs. per second ($\lambda = 1.25$ cm.).

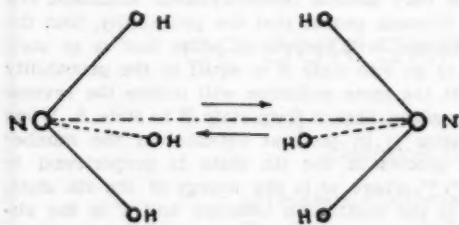


FIG. 1. Ammonia Inversion.

In employing ammonia for maser operation, the segregation of the species lying at the higher energy level is achieved by making use of the Stark effect. The ammonia molecules, as a well-collimated beam issue forth from a source chamber S [Fig. 2 (a)] and the beam is directed along the axis of an electro-static focussing system consisting of four or more electrical conductors [Fig. 2(b)] that are made alternately positive and negative.

In such a focussing system of electrodes the gradient of the electric field strength is away from the centre of the beam. Molecules in the

upper state are pulled in, towards the beam axis, while those in the lower state are expelled outward from the beam and thus physical separation of the molecules in the two states is accomplished. Molecules in the upper energy level is allowed into a microwave cavity C [Fig. 2 (a)] resonant at 24,000 Mcs.

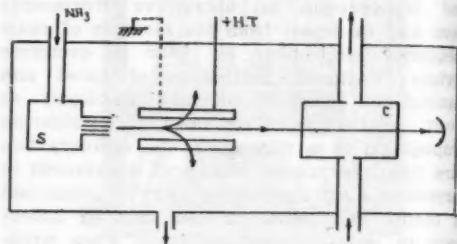


FIG. 2(a)

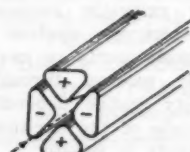


FIG. 2(b)

FIG. 2(a). Diagrammatic Representation of a Molecular Amplifier.

FIG. 2(b). Focussing Electrodes.

If, now, microwave wave radiation of this frequency is fed into the cavity, the molecules in the higher state give up their energy by stimulated emission of the same frequency and add radiant energy to the cavity. The radiation can induce the reverse transition and take up energy from the cavity. This, however, does not take place to any appreciable extent since a continuous stream of fresh charge of molecules at the higher energy level is brought into the cavity, and spent molecules are pushed out. Thus, on the average, energy from the molecule is added to it. If this gain in energy is greater than the losses in the cavity, more power can be taken from it than is supplied. Amplification at the frequency of 24,000 Mcs. has been obtained with ammonia molecule as the working substance.

An amplifier of this type can also be used as an oscillator. Such oscillators have very high frequency stability. The frequency of such an oscillation has been observed to have a random drift of only one part in 10^{13} in a period of two hours. The power output of the ammonia

the beam
are expel-
us physical
two states
per energy
cavity C

maser amplifier is low—of the order of 10^{-10} watt. But the great advantage of the ammonia maser is the low internal noise compared to the conventional amplifiers and because of this, amplification of very much weaker signals is possible with masers.

SOLID STATE MASER

The most successful maser amplifiers developed so far have been solid state three-level masers. Energy levels in a solid are very broad generally, but there are some atoms belonging to the transition and rare-earth elements notably, possessing sharp enough energy levels to be used as masers. Since such atoms are situated in a crystal lattice the levels undergo splitting because of Stark effect due to internal crystalline fields. Application of a magnetic field causes further splitting of the Zeeman type.

In Fig. 3 are represented three energy levels in a crystal. When the levels are in thermal

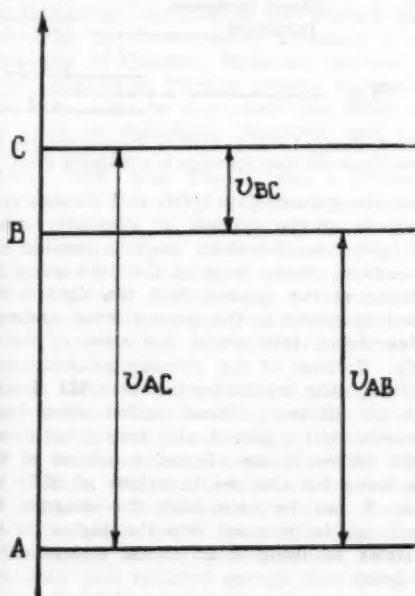


FIG. 3. Energy Levels in a Solid State Amplifier.

equilibrium the relative population in levels B and C will be $e^{-h\nu_{AB}/kT}$ and $e^{-h\nu_{AC}/kT}$ times the number in level A. When the crystal is exposed to intense radiation of frequency ν_{AC} a new equilibrium will be established, which equalises the numbers in levels A and C. The number in B however will be either less or greater

than A or C, depending upon the relative transition probabilities. If the transition probability for transition C-B is greater than B-A the number in B will be in excess of A. On the other hand, if the transition probability B-A is greater than C-B the number in level B will be less than in the levels A or C. In the former case where $T_{CB} \gg T_{BA}$ a maser operation of the crystal is possible at the frequency ν_{AB} while on the other hand when $T_{BA} \gg T_{CB}$ maser operation is possible at frequency ν_{BC} .

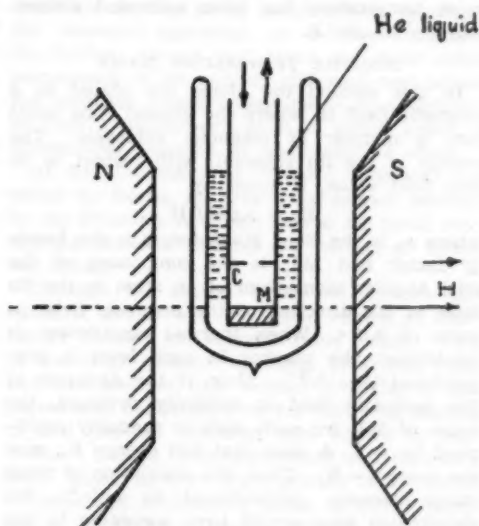


FIG. 4. Solid State Amplifier Operating at Liquid Helium Temperature.

Solid state masers are operated at liquid helium temperatures (4°K. or lower) for several reasons. The maximum gain obtainable will depend upon the population difference between levels B and A (N_B/N_A large). The maximum value of this ratio is $e^{-h\nu_{BC}/kT}$. If therefore the population in B has to be greater ν_{BC}/T should be large. Hence, the lower the temperature is, the higher the gain. Another important reason for operating at low temperature is that the desired low values of the lattice induced transition probabilities are attainable only at low temperatures. An enhancement of this transition probability contributes to the noise level of the amplifier. Further, such enhancement necessitates the expenditure of more power to maintain the equilibrium of population densities.

In spite of difficulties, successful amplifiers of this type have been constructed at Bell Telephone

Laboratories by Scovil, Feher and Seidel and by J. W. Meyers at the Lincoln Laboratory, M.I.T. The Bell Telephone maser uses a gadolinium atom in a crystal of gadolinium ethyl sulphate, operating at 9,000 Mcs. The Lincoln Laboratory maser uses chromium atoms in potassium chrom cyanide and operates at 2,800 Mcs. It amplifies linearly upto an output of 10^{-6} watt with a maximum output of 10^{-5} watt. The amplifier has gains of 40 db. and 10 db. with bandwidths of 25 and 500 Kcs. The noise temperature has been estimated conservatively at 100° K.

NEGATIVE TEMPERATURE MASER

In this method the atoms are placed in a magnetic field H , where the ground state splits into a number of magnetic sublevels. The energy of the i th sublevel, with respect to its zero field value, is given by

$$E_i = \mu_B g M_J H$$

where μ_B is the Bohr Magnetron, g is the Lande 'g' factor and M_J is the component of the total angular momentum of an atom in the i th state in the direction of the magnetic field, in units of $h/2\pi$. When thermal equilibrium is established, the number in each level is proportional to $e^{-E_i/kT}$. Now, if the direction of the magnetic field is suddenly reversed, the value of M_J for each state is suddenly multiplied by -1 . A state that had energy E_i , now has energy $-E_i$. Thus, the population of these states become proportional to $e^{+E_i/kT}$, the distribution they would have according to the Boltzmann formula for a temperature of $-T$; hence the term negative temperature. We have thus the requisite condition for maser operation, namely, a greater number of atoms in the upper state than in the lower.

Though this maser has got the advantage that it can be tuned to different frequencies by varying the magnetic field, it has other disadvantages. The operation of the maser will be intermittent because the energy source has to be periodically recharged. Further, a very low noise temperature is required in order to obtain a large population difference between the states.

OPTICALLY PUMPED MASER

Though a maser of this type has not been successfully operated so far, the idea of obtaining an excess population by optical pumping process is an interesting one. The case can be well discussed by taking sodium atom.

The familiar yellow lines in the spectrum of sodium atom are produced by transition from $2P_{3/2}$ and $2P_{1/2}$ states, to the ground $2S_{1/2}$ state (see

Fig. 5). When a sodium atom is placed in a magnetic field these levels undergo Zeeman splitting. The frequency that causes a transition between the $M_J = \frac{1}{2}$ and $M_J = -\frac{1}{2}$ sublevels into

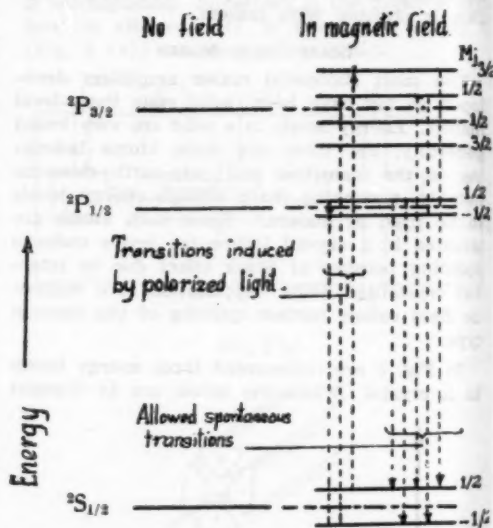


FIG. 5. Energy Levels in Sodium Responsible for the Yellow Lines and their Splittings in a Magnetic Field.

which the ground state splits is 5.6 megacycles per gauss of the applied. If circularly polarised light from a sodium lamp is directed into the sodium vapour kept in the field along the direction of the applied field, the light is absorbed by atoms in the ground level, undergoing excitation into one or the other of the $2P$ levels. Because of the circular polarisation of the light, only transitions in which M_J changes by 1 are allowed. These excited atoms spontaneously emit a photon and drop down to one of the $2S$ levels, the allowed transition in this case being for changes in values of $M_J = \pm 1$ or 0. It can be seen from the diagram the atoms can be pumped into the higher of the $2S$ states resulting in an excess population at the level.

This principle as stated at the outset has not resulted in any practical form of maser but offers promising possibilities.

Though the maser technique is of very recent origin and has not yet passed out of the research stage to the concrete instrumental stage, its possible future applications has aroused much interest. As stated, the low noise characteristic of this amplifier makes it especially suitable for greater ultimate sensi-

tivities in the field of radio astronomy, communication and radar. Especially, in radio astronomy where the signal strength is much smaller than the noise of the presently available amplifiers, this new principle of amplification

would have very fruitful applications. Masers can be designed to oscillate at very stable frequencies, thus providing highly accurate time standards.

A. JAYARAMAN.

MAX PLANCK

THERE are events in the development of Physics which reach far beyond the boundaries of science and have a decisive influence on the fate of humanity as a whole. Max Planck's *Quantum Theory* is an example of such a revolution of thought. Twenty-third April 1958 marks the 100th Anniversary of the birth of one of the greatest theoretical physicists of our times. Max Planck was born in Kiel on April 23, 1858, of family which had produced many government officials, jurists and scientists. When he was nine years old, his family moved to Munich. There, he attended the Maximilian Gymnasium and studied at the University for three years, acquiring a solid knowledge of Physics. However, the real spirit of research in Physics became apparent to him, only when he first came into touch with the work of Helmholtz, Kirchhoff and Clausius in Berlin.

Until 1877, Max Planck was a University Instructor in Munich. Two years later the Philosophy Faculty of the University of Berlin offered him a chair. Thus, Planck came in a world centre of science to work at the side of his venerated and admired Helmholtz. Here he advanced his thermodynamic research and arrived, thereby, at an entirely new field—Thermal Radiation.

From 1896 onwards Planck's principal goal was the theoretical derivation of the Laws of Radiation. Entropy had always appeared to him to be the essential concept of the Thermal Theory. Planck then turned to radiation and discovered the famous Radiation Formula which he made public at a Meeting of the Berlin Physics Society on October 19, 1900. He recognized that radiated energy was not arbitrarily divisible, but had a type of atomic structure, or, as Planck said, exists in an ascertainable fixed quantum. The radiated energy quantum of a fixed frequency is proportionate; the proportionality factor signified by letter 'h' is a universal constant, which Planck called the efficiency quantum—usually called simply "Planck's Constant".

In 1905, Einstein took up the quantum idea. He showed that Planck's first interpolative

derivation of the Radiation Formula can be so expanded that the existence of the energy quantum appears to be an inevitable result of the observed spectrum of thermal radiation. He further showed that there are many other phenomena of an entirely different sort where the quantum comes under observation directly, as light quanta—or, as it is called today, a Photon—for instance in photo-electric effect.

At the insistence of Planck, Einstein was called to Berlin in 1913 to a special position in the Prussian Academy where he could pursue his research without the burden of teaching duties.

Through the united efforts of Planck and Einstein, Berlin was the world centre of theoretical physics for almost twenty years. Two of the most eminent of them, Max von Laue and Lise Meitner, also worked in Berlin in this period and contributed to the lustre of physics in that Capital. Students who wished to hear Planck's famous lectures streamed in, from every land. These lectures were printed in six small volumes and contributed much to the dissemination of Planck's ideas. Planck was made permanent Secretary of the Mathematics and Physics Department of the Berlin Academy and gave much time and effort to this task. In 1928 at the age of seventy he retired from his teaching position at the University of Berlin. His successor was Erwin Schrödinger, one of the discoverers of wave mechanics. However, Planck retained the leading position at the Academy.

When the National Socialists seized power in 1933 and began to dismiss many officials and professors because of political unacceptability or Jewish ancestry, Planck, as President of the Kaiser Wilhelm Society, attempted to intervene with Hitler on behalf of various colleagues. He had no success. Einstein announced his withdrawal from the Academy and thereby spared his friend the humiliation of having to inform him of his expulsion. Schrödinger, although uncontested, resigned his Professorship of his own free will and went abroad. The great period of theoretical physics was over in Berlin.

The final stage of the war brought Planck his most severe trial. His son, Erwin, the only surviving child of his first marriage, was involved in the attempt on Hitler's life on July 20, 1944, and condemned to death. Then, Planck stood before the most difficult decision that can confront a man. A reprieve was offered to his son provided Planck signed an oath of loyalty to Hitler. He refused the signature and his son was executed.

Planck's house in the Grunewald, a suburb of Berlin, was destroyed in an air raid and all his possessions including his valuable library were lost. Together with his wife, he took refuge on an estate of a friend at Rogätz near Magdeburg. There, they were caught between the advancing Allied armies and the retreating German army. The battle roared around them for days, until finally they were brought to Göttingen by American troops. Planck found a new, simple home in Göttingen, but hardly ever came to rest there since he felt it his duty to accept invitations to lecture, which carried him on long and strenuous journeys.

In 1946, Planck took part in the observance of the 200th anniversary of Newton's death (postponed), which was arranged by the Royal Society in London, and was honoured as the founder of a new research period in phy-

sics. Honours of every sort were heaped upon him—Doctorates of all Faculties in many lands; memberships or honorary memberships in leading Academies; the Nobel Prize of 1919; the Goethe Prize of the City of Frankfurt for 1946, and many other prizes, orders and medals.

A great celebration was planned in honour of his ninetieth birthday. However, a month prior to this day, Planck's health broke and he died in Göttingen on October 4, 1947. A memorial service was held on April 25, 1948, in Göttingen in which representatives from all over the world as well as from all parts of Germany participated.

Today, more than fifty years after his great discovery, the significance of Planck's life work can well be assessed. Through Planck's thought, nuclear physics has become an exact science, with its own laws which differ in a characteristic manner from those of the classical theory. With the passage of time these laws have been systematized under the names Quantum Mechanics and Quantum Electrodynamics, to a perfection equalling that of the classical Celestial Mechanics which until 1900, was considered to be the model of an exact theory. The Nuclear Age, on the crest of which we stand, with all its hopes and dangers, would be unimaginable without the theoretical equipment provided by the Quantum Theory.

NEW TYPE OF REFLEXES

THE discovery of a new type of reflexes has been announced by Leonid Krushinsky, Professor of Physiology, at Moscow University.

Krushinsky has been studying reflexes in animals for a long time and his experiments have led him to the conclusion that animals, besides having conditioned and unconditioned reflexes, have a third type which he calls extrapolatory or prognosticating reflexes. This type is the basis of rational activity and of the ability of highly organised beings to conceive a picture of a process as a whole, to compare individual phenomena and foresee future events whose causes are sensed by the organs of the animal.

He has established that certain species of animals and birds possess extrapolatory reflexes in varying degrees of development which is a direct result of their environment. They are innate, but become manifest when sufficient experience has been gained.

Krushinsky believes that the basis for the emergence of these reflexes is the existence in

the cortex of the brain of special neuron apparatus—"an operative memory"—which selects and records the natural regularity of certain changes, the direction and speed of movements in particular. It is the knowledge of these regularities that makes it possible to forecast (extrapolate) the subsequent changes and to react to them properly.

Thus, this new type of reflexes, in contrast to the conditioned and unconditioned, is not a direct reaction to a stimulant acting at a given moment. Moreover, in certain cases they may clash with conditioned reflexes since the latter form the basis of more or less stereotyped action.

According to the degree of development of its extrapolatory reflexes, the animal is capable of solving problems of varying complexity. Experience has shown that an animal compelled to solve problems above its possibilities develops a nervous breakdown and sickness. Overstraining the extrapolatory reflexes results in neuroses.

THE CHEMISTRY OF NUCLEIC ACIDS

T. R. SESHADRI

Department of Chemistry, University of Delhi

NUCLEIC acids are probably the most vitally important of natural polymers from the point of view of the living system. In several ways, their chemistry has been far more complex than that of other well-known polymers like polysaccharoses and proteins. That, in this difficult field, a stage of definite achievement has been reached at the present time is largely due to the great work of Prof. Sir Alexander Todd and his collaborators during the past fifteen years and this has been recognised by the recent award of the Nobel Prize to him.

OCCURRENCE

The first isolation of a nucleic acid was made from pus cells and egg yolk in 1871 by Miescher. He found that they were usually associated with proteins and had to be liberated by means of alkali or enzymes. He noted also their marked acid property and insolubility in usual organic solvents. Many other sources of nucleic acids have subsequently been found, such as yeast, thymus gland and fish sperm. They are widely distributed in plants and animals and their existence in bacteria and viruses has considerable interest.

At one time it was thought that there was definite distinction between plant nucleic acids and animal nucleic acids and that the former was based on ribose and the latter on desoxyribose. The names Ribo Nucleic Acids (RNA) and Desoxyribo Nucleic Acids (DNA) were given to them. Later discoveries have shown that this is not so, and both types are found in plants, as well as in animals. But each is present in a different part of the cells; for example, the cytoplasm contains RNA, and the nucleus DNA; and each group has probably a different function to perform.

ISOLATION

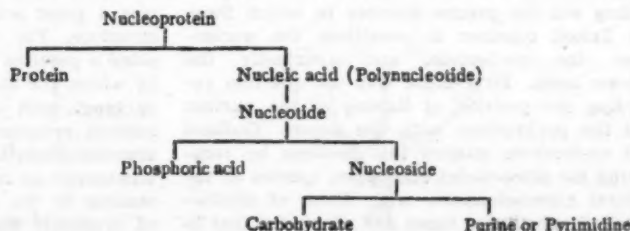
As already mentioned, the nucleic acids occur in combination with proteins (nucleoproteins)

intimately associated with the cells. The main stages in the isolation involve the destruction of the tissues, the separation of nucleic acids from proteins and finally precipitation and purification of the nucleic acids. For the first two stages sodium hydroxide in the cold or in the hot is employed and precipitation effected with hydrochloric acid. This works well for the preparation of yeast nucleic acid. The use of alkali has a great disadvantage, since the nucleic acid molecule is liable to break down during the treatment and hence alternative methods such as extraction with hot aqueous sodium chloride, heat denaturation and disruption by ultrasonic waves have been recommended. Their purification is extremely difficult and homogeneous preparations are rarely obtained.

ANALYTICAL STUDIES

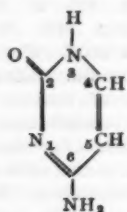
We owe a great deal to the pioneering and extensive work of Levene. As already mentioned, nucleic acids are large molecules made up of a number of smaller units called nucleotides. The conversion of nucleic acids into nucleotides is conveniently effected by mild hydrolysis, e.g., heating with dilute ammonia at 115° C. for 1 hr. These nucleotides occur free to some extent and they have been shown to be made up of three components, a purine or pyrimidine base, a sugar, and phosphoric acid. When treated with sodium hydroxide phosphoric acid alone is cleaved leaving the other two parts together, in what is called nucleoside (glycoside). Further acid hydrolysis liberates the free purine or pyrimidine base and D-ribose in the case of RNA and D-desoxyribose in the case of DNA.

The basic part of different nucleotides varies. It may either belong to the purine group such as adenine and guanine or to the pyrimidine group such as cytosine, uracil and thymine. The constitution of the purines and pyrimidines

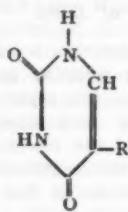
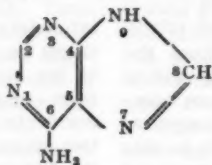


had been established earlier mainly by the work of Emil Fischer's school.

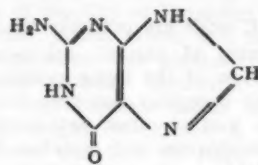
purines it was the 9 position and in pyrimidines the 3 position. In view of the close re-



Cytosine

Uracil R = H
Thymine R = CH₃

Adenine



Guanine

D-ribose and D-desoxyribose were first identified by Levene and Jacobs (1908-11) as hydrolytic products of nucleic acids. This was the first discovery of these sugars in Nature. Later they have been found to be present in other sources too. It is interesting to note that D-ribose was known much earlier as a synthetic product, synthesised by Emil Fischer in 1901, in the course of his study of carbohydrates. He also synthesised desoxyribose in 1913. These are probably two of the most important carbohydrates occurring in Nature. In 1935, Levene and Tipson showed that these sugars are linked with the bases in the form of glycosides and the rate of hydrolysis of the nucleosides is like those of other glycosides. They also showed that in the combination they exist in the furanose ring form. This information was obtained by complete methylation and hydrolysis. The resulting trimethyl ribose yielded dimethyl tartaric acid on oxidation. Later on, Todd and his co-workers used periodic acid titration and showed that in ribonucleosides there are only two hydroxyl groups in the neighbouring positions thus confirming the furanose structure. This is a handy method of diagnosis of the ring structure present in natural as well as synthetic ribosides and has also been ingeniously used for determining the β -configuration of the glycosidic linkage.

Though the nature of the ultimate units composing the nucleic acids was known fairly early, there has been considerable difficulty in finding out the precise manner in which these are linked together to constitute the nucleosides, the nucleotides and eventually the nucleic acids. First there was the question regarding the position of linking of the purines and the pyrimidines with the sugars. Gulland and co-workers studied this problem by comparing the ultra-violet absorption spectra of the natural ribonucleosides with those of synthetic alkyl substituted bases and concluded that in

semblance between the ribose and desoxyribose derivatives the same positions have been considered to be occupied by the desoxyribose units also.

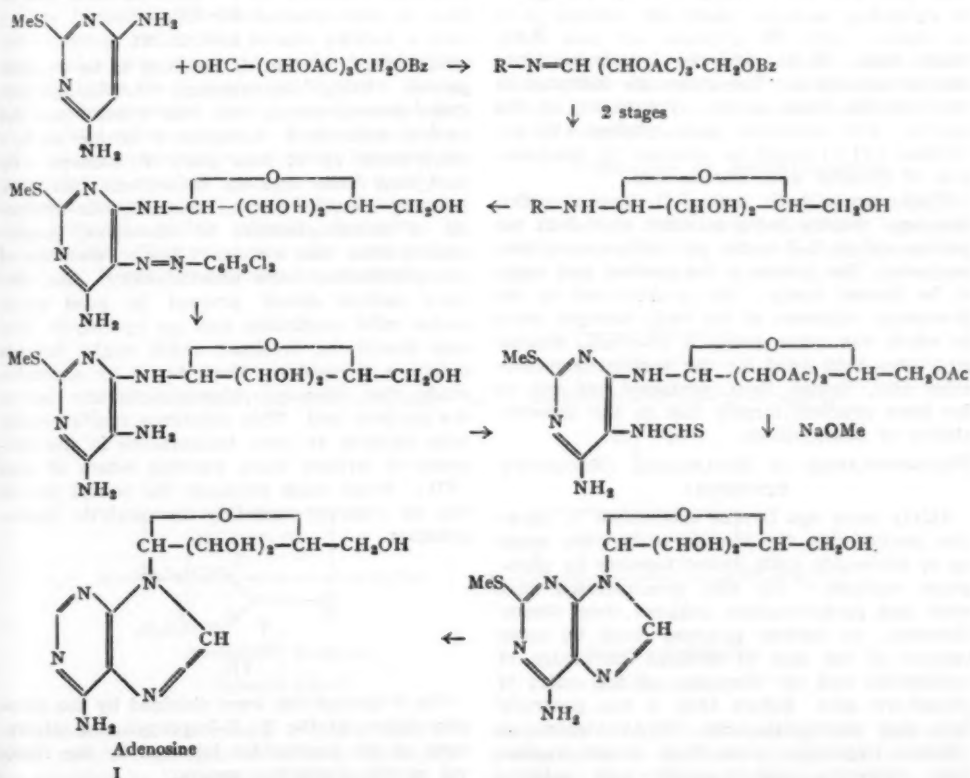
SYNTHETIC WORK

As already mentioned, the discovery of nucleic acids was made more than eighty years ago. However, it is only during the last decade that definite progress in the study of their structures has been possible. This long delay was due to the lack of precise knowledge of the structure and properties of the simple nucleosides and nucleotides, formed as products of hydrolysis. A marked difference exists between nucleic acids and other well-known high polymers occurring in Nature. In carbohydrates and proteins, the monomers are bifunctional simple entities like mono-saccharoses and amino acids. In the case of nucleic acids, the nucleotide monomers consist of three different parts and the inter-linkages were difficult to establish. Further, other difficulties existed, e.g., the nucleotides which are polar substances are insoluble in common organic solvents and are very difficult to handle by the classical methods of organic chemistry. The intensive development of nucleotide chemistry had therefore to await the introduction of new experimental techniques. The important synthetic studies can be considered under three heads.

STRUCTURE AND SYNTHESIS OF NUCLEOSIDES

The total synthesis of the four ribonucleosides was a great achievement and established their structure. For the synthesis of purine nucleosides a possible route was that of Emil Fischer in which the silver salt of the purine is made to react with an aceto-halogeno-sugar. This method required the unknown (at that time) acetohalogenoribofuranose and was not unambiguous as regards the location of the sugar residue in the product obtained. A new type of synthesis was therefore developed by Todd

and his co-workers. It involved the preparation of a glycoside of a pyrimidine, with subsequent completion of the purine nucleus by building up the second ring. Though this method needed long and difficult exploration, it was successfully developed leading to the final synthesis of adenosine. The essential stages are outlined below:



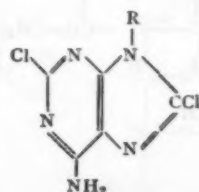
Adenosine (I) was also synthesised by an extension of Fischer's method. Acetochlororibofuranose (II) prepared from 5-trityl ribose was treated with silver 2:8-dichloroadenine (III, R = Ag) and the product deacetylated, giving



II X = Cl or Br

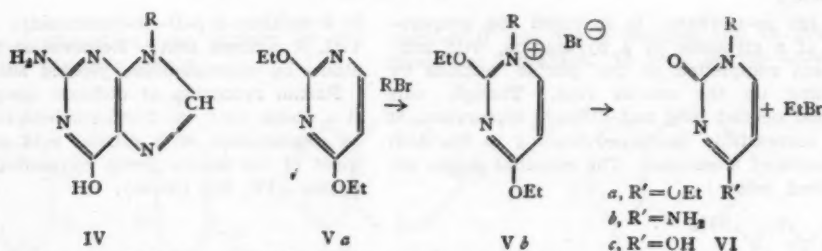
2:8-dichloro-9-β-D-ribofuranosidyl adenine (III, R = ribose unit). Removal of the chlorine atoms by hydrogenation yielded adenosine (I).

Partial reduction of dichloro compound (III, R = ribose unit) to 2-chloroadenosine followed by deamination with nitrous acid and replacement of the chloro group by amino, gave guanosine (IV, R = ribose).



III

For the synthesis of cytidine (VI b), aceto-bromoribofuranose (II, X = Br) was treated with 2:6-diethoxypyrimidine (V a). This involves a reaction characteristic of heterocyclic compounds in which quaternary ammo-



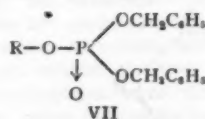
nium salts (V b) undergo conversion into dihydroderivatives. The stages are indicated in the formulæ given above. Treatment of the product with ammonia gave cytidine (VI b). Uridine (VI c) could be obtained by deamination of cytidine with nitrous acid.

They are in each case β -D-ribofuranosides, the sugar residue being attached at N-9 in the purine and at N-3 in the pyrimidine units respectively. The β -form is the stablest and tends to be formed easily; this is attributed to the favourable influence of the basic nitrogen atom to which the sugar group is attached. Similar structures hold good for the desoxyribonucleosides also, though their synthesis has not so far been effected, largely due to the unavailability of desoxyribose.

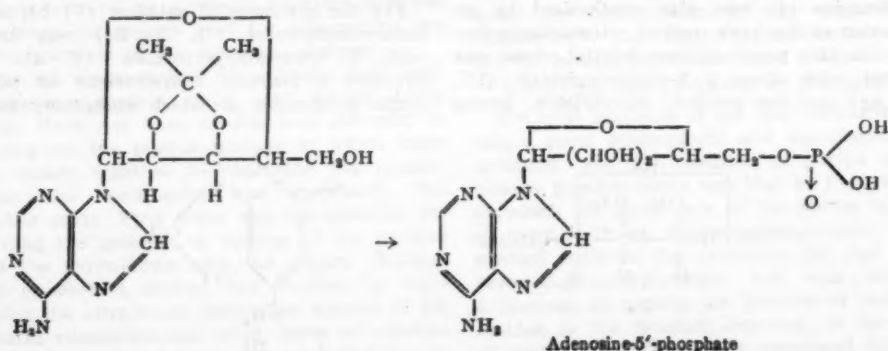
PHOSPHORYLATION OF NUCLEOSIDES (NUCLEOTIDE SYNTHESIS)

Thirty years ago Levene established by titration studies that the nucleic acids were made up of nucleoside units linked together by phosphate residues. He also demonstrated that ether and pyrophosphate linkages were absent. However, no further progress could be made because of the lack of detailed knowledge of nucleosides and the chemistry of the esters of phosphoric acid. Before 1949, it was generally held that ribonucleic acid (RNA) yielded on alkaline hydrolysis only four simple nucleotides (adenylic acid, guanylic acid, uridylic

acid and cytidylic acid) believed to be 3'-phosphates. Using ion-exchange chromatography, Cohn showed during this year (1949) that the hydrolysates really contained 8 simple nucleotides made up of four pairs of isomers. By that time Todd and his co-workers had been devising methods for the unambiguous synthesis of mononucleotides of adenosine, guanosine, uridine and cytidine. Earlier methods of phosphorylation were unsatisfactory. An efficient method should proceed in good yields under mild conditions and no hydrolytic process should be involved which might damage sensitive glycosides. They found by extensive study that dibenzyl chlorophosphonate serves the purpose best. This substance reacts readily with alcohols at room temperature in the presence of tertiary bases yielding esters of type (VII). From these products the benzyl groups can be removed smoothly by catalytic hydrogenation.



The 5'-phosphates were obtained by the phosphorylation of the 2':3'-isopropylidene derivatives of the nucleosides followed by the removal of the protecting groups.



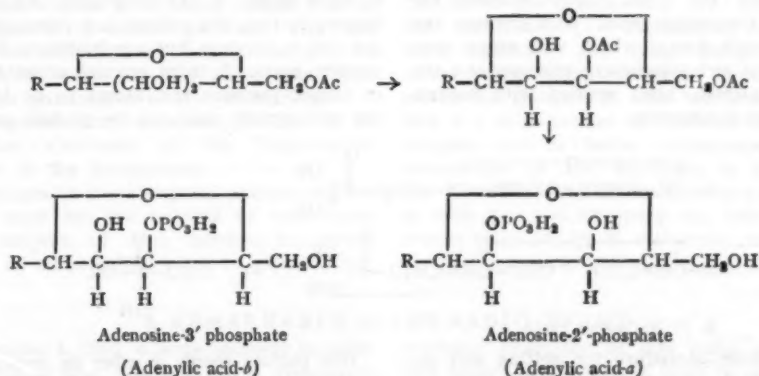
Subsequently Brown and Todd synthesised adenosine-2', and adenosine-3'-phosphates by phosphorylating 5'-trityladenosine and separating the mixture of products by ion-exchange chromatography. They were identical with the adenylic acids -a and -b of Cohn, but which was the 2' and which the 3' it was impossible to say with certainty. This was first indicated by the hydrolysis of the isomers with an acid ion-exchange resin. The former yielded a product which was identified as the 2'-phosphate and the latter the 3'-phosphate of ribose. Confirmation was provided by the partial acetylation of 5'-acetyl adenosine to 3': 5'-diacetyl derivative, the phosphorylation of which followed by deacetylation yielded adenylic acid-a alone; it should therefore be 2'-phosphate of adenosine and adenylic acid-b should therefore be 3'-phosphate. This point has also been established by X-ray crystallographic methods.

phate considered to be an intermediate. The process of hydrolysis is indicated in the following scheme and the peculiar reaction is attributed to the presence of a *cis*-hydroxyl group in the concerned system.

The structural analogy between these nucleotide mono-esters and poly-nucleotides was recognised by Brown and Todd and they used it to explain the ready alkaline hydrolysis of RNA and the stability of DNA (which do not have the 2'-hydroxyl) under same conditions. They also advanced the general formulation of both types of nucleic acids as 3'-5'-linked polynucleotides.

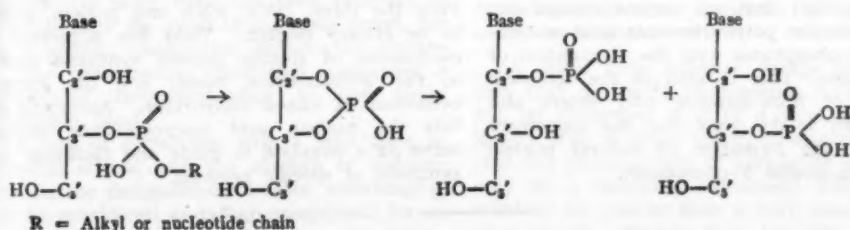
FORMATION OF POLYNUCLEOTIDES

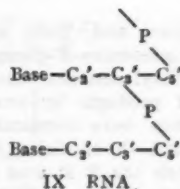
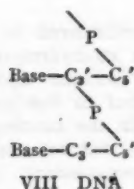
The general structures at present accepted for DNA and RNA are indicated in formulae (VIII) and (IX). In these representations the sugar part intimately connected with the inter-



Explanation of the results of Cohn who obtained pairs of phosphates of each nucleoside was provided by the study of the migration of the phosphate groups. A significant observation was the lability of nucleotide mono-esters towards alkali. These undergo hydrolysis readily and yield mixtures of the unesterified 2' and 3'-phosphates along with a cyclic 2'-3'-phos-

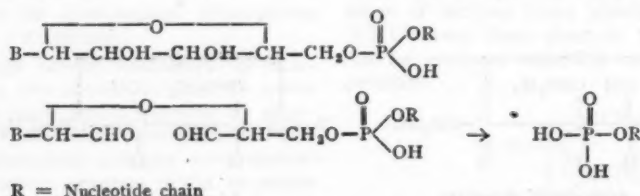
nucleotide linkage and bearing free hydroxyl groups alone is specified. In the case of DNA evidences are derived from the stability towards alkali and the course of enzymic and acid hydrolysis. In regard to RNA definite proofs have been more difficult to obtain but they have been provided by studying the action of specific enzymes on these nucleic acids.





The linear structures represented above for both types of nucleic acids are in accord with their properties and X-ray evidence. Individual nucleic acids may be expected to differ substantially in the sequence of the nucleotide residues and hence methods of sequence determination are necessary in order to have a complete picture. In the analogous case of polypeptides stepwise degradation from an end has been successfully employed for this purpose. But the problem is far more difficult in nucleic acids because of the greater instability of the phosphate linkages. An interesting method has been suggested by Todd and co-workers for the study of ribonucleic acid. This involves the use of periodate fission which will affect only one end group and subsequent elimination; the method has already been applied with success to small oligo-nucleotides.

As the next step the conformation of nucleic acid macromolecules could be considered; this has received a great deal of attention. Salts of DNA can be obtained in crystalline fibre form and are quite suited for X-ray studies. They appear to have the form of a double helix. According to Watson and Crick (1953) they exist as a kind of double molecules consisting of two polynucleotide chains in the form of right-handed helices coiled round the same axis and held together by hydrogen bonds. The phosphate groups are on the outside and the purine and pyrimidine bases lie inside the helix at right angles to the long axis. An important feature is that the purine and pyrimidine bases are not at random but are hydrogen-bonded in specific pairs. A third coaxial chain is present in nucleoproteins and seems to be formed by the polypeptide chain of the protein component.



An alternative procedure for getting this information will be stepwise synthesis. This has also been shown to be possible. Michelson and Todd have synthesised a dithymidine-dinucleotide containing the 3'-5'-inter-nucleotide linkage and have shown that the behaviour of the synthetic material towards enzymes is exactly the same as that of dinucleotide fragments obtained by degrading desoxyribonucleic acids.

Another important recent discovery is that of Ochoa (1955) that an enzyme system can rapidly synthesise polynucleotides from nucleoside 5'-pyro-phosphates with the elimination of orthophosphate. This is akin to the technical production of fibre-forming poly esters and lends support to the view that the monomers involved in the formation of natural nucleic acids are nucleoside 5'-phosphates.

This picture seems to offer an important clue to the way in which hereditary patterns are passed on during cell division and also how mutation can take place. DNA being characteristic components of chromosomes seem to play a vital part in heredity transmission. They have a key function in controlling the synthetic processes in the cell and this is obviously related to protein synthesis. This function seems to be carried out through the help of the RNA which occur largely in the cytoplasm. Thus the three, DNA, RNA and protein, seem to be closely related. Todd has suggested a mechanism of specific protein synthesis based in the Watson-Crick model and the known behaviour of mixed anhydrides. According to this the nucleic acid macromolecule should serve as a template to guide and facilitate the synthesis of specific proteins.

SYMPOSIUM ON THE MONSOONS OF THE WORLD

A THREE-DAY Symposium on the Monsoons of the World, organised jointly by the International Association of Meteorology and Atmospheric Physics of the International Union of Geodesy and Geophysics, the World Meteorological Organisation and the Government of India, was held from the 19th to 21st February 1958, at New Delhi. It was inaugurated on the 19th February by Dr. K. S. Krishnan, Director of the National Physical Laboratory, India and Vice-President of the International Council of Scientific Unions. More than 300 scientists directly or indirectly interested in Meteorology were present. Dr. K. R. Ramanathan was elected Chairman.

The timing of the Symposium was adjusted so as to make it follow immediately the Second Session of the Commission for Synoptic Meteorology of the World Meteorological Organisation, which was held at Delhi between January 21 and February 17, 1958. This enabled the delegations of many nations, who had attended the Meetings of the Commission for Synoptic Meteorology, to stay on for the Symposium and participate in its proceedings.

The delegates were welcomed by Dr. K. R. Ramanathan, Convener of the Organisation Committee of the Symposium.

Dr. Krishnan in his inaugural speech emphasised the need for the holding of such symposia on subjects of wide interest, for better promotion of all scientific work in general, and

of scientific work in the earth sciences in particular.

The officers of the Indian Meteorological Department had to put forth intense effort to organise the Symposium at very short notice.

Prof. H. Flohn of the Meteorological Service of the Federal Republic of Germany was the only invited expert who could participate in the Symposium. His papers were thought-provoking, particularly his arguments that the monsoon of India has worldwide connections and was an important part of the general circulation of the atmosphere.

The Symposium lasted for full three days. Thirty-four papers falling under the following seven headings: (1) Climatology of the Monsoons—Surface and Upper Air; (2) Monsoons and the General Circulation; (3) Dynamics of the Monsoons; (4) Depressions and Other Perturbations in the Monsoon; (5) Rain and Clouds of the Monsoons; (6) Variability of the Monsoons; (7) Forecasting of the Monsoon—Extended and Long Range, were received. Discussion followed presentation of papers in groups. It was the general feeling that the deliberations of the assembled meteorologists led to better understanding of the phenomena of the monsoons in Asia, Africa and Australia. The Symposium came to a close at 6-30 p.m. on February 21, with a vote of thanks from Dr. P. R. Pisharoty, the Secretary of the Organising Committee. P. R. P.

A REMARKABLE SOLAR RADIO EVENT

ON November 4, 1957, a large increase in solar radio noise was observed on a frequency of 200 Mc./s. at the receiving station 'Nera' of the Netherlands Telecommunications Services. The increase started rather abruptly at 0048 U.T. and lasted for more than 5 hrs., the greatest intensity being reached at about 0930 U.T., when it amounted to approximately 900 times the noise level of the quiet Sun. The smoothed intensity level showed considerable fluctuations with periods of the order of a few minutes. No solar flare has been reported as occurring near the onset of the radio event, nor was a sudden ionospheric disturbance observed. The phenomenon manifested itself over a considerable frequency-range in the metre wavelength band.

The lack of correlation with a solar flare or associated effects, and the absence of disturbances on the decimetre-centimetre wavelengths, must be considered as rather exceptional for so large a 200 Mc./s. event. However, the extra-

ordinary character of this radio phenomenon was particularly apparent from records obtained with a negligible time-constant.

No ionospheric scintillation of radio sources of any importance was observed at the Jodrell Bank Experimental Station or at the Mullard Radio Astronomy Observatory on November 4. Ionospheric scintillations of so short a period have never, in fact, been observed in Cambridge (Dr. A. Hewish, Private communication). The very short-period fluctuations of intensity must also, therefore, be ascribed to solar conditions.

All these facts together justify the conclusion that the radio phenomenon which occurred on November 4 is of a new, so far unknown type of great rarity. It should be noted that this peculiar type of variability is revealed only by a recording instrument with a time-constant no greater than a very small fraction of a second. (*Nature*, Vol. 181, 542, 1958.)

OBITUARY: PROFESSOR M. DAMODARAN

BY the death of Professor M. Damodaran last December, Biochemistry lost one of its great pioneers. He had long been recognised as a leading Biochemist in India. He was educated at the Presidency College, Madras. After a brilliant academic career he received preliminary training in research at the Indian Institute of Science, Bangalore. The award of a research scholarship by the Government of Madras enabled Damodaran to continue his studies in Germany and England. In Germany (1928) he had the unique privilege of working with Abderhalden—the father of Protein Chemistry—on the preparation and enzymic digestion of myristic acid peptides. Later, under the inspiring leadership of Professor A. C. Chibnall, Imperial College of Science and Technology, London, he continued the work in the domain of Protein Chemistry. During 1929-32, he established the first direct proof of the 'Amide Hypothesis' in proteins, by isolating asparagine and glutamine from enzymic digests of edestin and gliadin respectively. This remarkable contribution gained him the Degree of D.Sc. (London).

Returning to India towards the close of 1932, he was appointed first Reader of Biochemistry at Madras University. Subsequently, he became Professor and held the post till 1948, when he was invited to assume Directorship of the Biochemical Division at the National Chemical Laboratory, Poona (then temporarily housed at Delhi). Later, he assumed the Deputy Directorship of the Laboratory and his retirement due to ill-health in the middle of 1956 was very much regretted by all his colleagues.

Professor Damodaran's scientific publications are legion and cover a wide range of problems

in Biochemistry. Demands on brevity restrict one from presenting a detailed account of his work. During the thirties one notices his work on proteins from seeds, viz., cashew-nut, water-melon seeds, canavanine from *Canavalia obtusifolia*, isolation of L, 3:4-dihydroxy-phenyl alanine from the seeds of *Mucuna pruriens*, enzymic proteolysis, amino acids of casein phosphopeptide. He demonstrated for the first time the presence of glutamic dehydrogenase in germinated seedlings. This was followed up by his finding succinic dehydrogenase in germinated seedlings.

Though a Protein Chemist at heart, Professor Damodaran gave prominence to problems having economic or medical application—in keeping with the need of the day. To this difficult and exacting task he has given freely and unstintingly of his time, of his vast store of experience and of himself. He bred a remarkably active strain of *Aspergillus niger* for the production of citric acid from sugar. Another notable achievement is his synthesis of ascorbic acid from sorbitol, with a 99% intermediary yield of sorbose. His gelatin plasma substitute preparation, based on a tryptic digestion, is undoubtedly his most spectacular contribution towards alleviation of human suffering. This has been clinically tested with excellent results.

Professor Damodaran was an expert analyst. He brought his great scientific skill and precision to bear on methods of separation, isolation and identification in the immensely complicated chemistry of living matter. His students, and all who knew him will mourn the loss of this truly great leader in science.

K. RAMAMURTI

THE PROPERTIES OF THROMBINOGEN

IN a paper that has appeared in *Canadian Journal of Biochemistry*, Vol. 36, 75, 1958), evidence is given which demonstrates the existence of an intermediate, designated thrombinogen, during the conversion of prothrombin to thrombin. The conversion of prothrombin to thrombin requires thrombin, though other tryptic enzymes can replace thrombin. The properties of thrombinogen have been studied.

As a result of observations on the properties of thrombin the author suggested that an in-

termediate, designated thrombinogen, is formed during the conversion of prothrombin to thrombin. Shulman and Spaet on independent grounds, also recognized the inadequacy of a simple conversion of PT to T. The validity of the proposal has now been demonstrated. As a guide to isolation attempts, the studies reported were undertaken to determine some of the chemical and physical characteristics of this intermediate.

LETTERS TO THE EDITOR

AN EMPIRICAL FORMULA FOR THE
MASSES OF THE ELEMENTARY
PARTICLES

THE π^\pm meson has a mass of $273 m_e$, where m_e is the mass of the electron. It has previously¹ been pointed out that this value is very nearly twice the reciprocal of the fine structure constant, α . Thus

$$\pi^\pm = 2/\alpha = 2(137) = 274 \quad (1)$$

Similarly, the μ^\pm meson has a mass of $207 m_e$, which is very close to the value

$$3/2\alpha = 3(137)/2 = 206 \quad (2)$$

Among the hyperons (the elementary particles heavier than the neutron), the mass of the Λ^0 particle is $2181 m_e$, that of the Σ^\pm particles is $2327 m_e$, and the mass of the Ξ^- particle, the heaviest known elementary particle, is $2586 m_e$. Now we find, quite astonishingly, that these masses are related to the mass of the proton ($= 1836 m_e$) in the following manner:

$$\Lambda^0 = p^+ + \mu + 1/\alpha = 1836 + 207 + 137 = 2180 \quad (3)$$

$$\Sigma^\pm = p^+ + \mu + 2/\alpha = 1836 + 207 + 2(137) = 2317 \quad (4)$$

$$\Xi^- = p^+ + \mu + 4/\alpha = 1836 + 207 + 4(137) = 2591 \quad (5)$$

These relations suggest that a hyperon intermediate in mass between the Σ and Ξ particles, with mass 2454 and as yet undiscovered, might be capable of existence:

$$p^+ + \mu + 3/\alpha = 2454 \quad (6)$$

Taking the foregoing relationships into account, the following formula, which permits the calculation of essentially all the known elementary particle masses,² can be derived:

$$M = n_1 M_p + (n_3 + \frac{3}{2} n_2 - \frac{9}{2} n_1) / \alpha \quad (7)$$

In this equation, M is the desired elementary particle mass, $M_p = 2454$, $\alpha = 1/137$, and n_1 , n_2 and n_3 are small integers or zero, and these may therefore be called "mass quantum numbers".

Equation (7) can then be written

$$M = 2454 n_1 + 137 \left(n_3 + \frac{3}{2} n_2 - \frac{9}{2} n_1 \right) \quad (7a)$$

Table I gives the values which these integers must have in order to reproduce the elemen-

tary particle masses. The results of the calculation and the observed values of the masses are also shown in the table.

TABLE I

The integer values of the "mass quantum numbers" and the masses of the elementary particles as calculated from Eq. (7a)

Particle	n_1	n_2	n_3	Calc. Mass	Obs. Mass
π^\pm	0	1	0	206	207
$\pi^\pm (\pi^0)$	0	0	2	274	273 (264)
$\tau^\pm (\nu^0)$	0	2	4	951	966 (965)
$p^+ (n^0)$	1	0	0	1837	1836 (1839)
Λ^0	1	1	1	2180	2181
Σ^\pm	1	1	2	2317	2327
Ξ^-	1	1	4	2591	2586

For the known particles, n_1 has only two values, 0 and 1, and is seen to be identical with the so-called baryon number; n_2 has three values, 0, 1 and 2, and it is interesting to note that all four particles having $n_2 = 1$ have also the same spin³ ($\frac{1}{2}$); n_3 takes on four different values, 0, 1, 2 and 4, and it should be noted that particles having the same value for n_3 have also the same value for the Z component of isotopic spin (T_z).

The existence of additional particles, as yet unobserved, may possibly be capable of prediction by selecting other combinations of the mass quantum numbers.⁴

Stevens Inst. of Technology,
Hoboken, N.J., U.S.A., January 3, 1958.

LEONARD S. LEVITT.

1. Nambu, Y., *Progr. Theoret. Phys.*, 1953, 10; also Yo-hikawa, S. and Hasebe, T., *Ibid.*, 1953, 10, 359, and 1954, 11, 496; also Ezatsu, H., *Ibid.*, 1954, 11, 125 and 1955, 12, 363.

2. The π^0 meson and neutron have masses very close in value, respectively, to the π^\pm mesons and proton, as shown in parentheses in Table I.

3. In this regard the $3/2$ coefficient of n_2 in Eq. (7) is suggestive.

4. In this connection it is interesting to note that when $n_1 = 0$ and $n_2 = 4$, or $n_2 = 2$ and $n_3 = 1$, a particle of mass 548 is predicted; and Alikhanian has recently reported the detection of particles of mass 550. (Alikhanian et al., *Zhur. Eksp. i Teoret. Fiz.*, 1956, 31, 955.)

DETERMINATION OF BLOOD MEALS OF INDIAN *CULICOIDES* (CERATOPO- GONIDÆ : DIPTERA)

Culicoides have been known to feed not only on mammals but occasionally also on birds, reptiles and even on insects (Hill, 1947). Information on the nature of feeding in Indian *Culicoides* is however very meagre. Some observations are no doubt on record but there is a considerable lack of unanimity. Kieffer (1910), Macfie (1932) and Mukerji (1931) report that the *Culicoides* investigated by them were mostly cattle-blood feeders, whereas Edwards (1932) and Smith (1929) consider a few among them as feeders on human blood. One species, *C. orystoma* has also been recorded as feeding on earthworms (Patel, 1922), while *C. anophelis* has been variously reported as feeding on mosquitoes (Das Gupta and Ghosh, 1957).

Culicoides with typical piercing mouth-parts appear ideally suited for feeding on animals or man, but in actual habit they have not conformed to this on more occasions than expected. We therefore undertook some analytical tests of the stomach fluid of the insects with precipitin sera, and also induced them to feed under laboratory conditions on small rodents and man to find out their feeding preferences, if any. Altogether 15 species have been examined (*C. anophelis*, *C. peregrinus*, *C. palpifer*, *C. alatus*, *C. macfei*, *C. similis*, and nine undescribed ones).

The observations so far carried out indicate that nearly all the species locally available readily take to cattle blood and as large a number as 13 species (including all the described species excepting *C. anophelis*) proved positive for cattle blood in precipitin tests. *C. anophelis* did not react to anti-human or anti-ruminant sera although they were taken from engorged mosquitoes in cattle sheds or human habitations. This however does not preclude the possibility of the species drawing mammalian blood from host insects and an extremely rare incidence of the species feeding directly on cattle has also been described (Smith and Swaminath, 1932). In the absence of positive evidence ascribing the nature of the feed this species resorts to, we are inclined to believe that the chief source of nourishment of *C. anophelis* is the haemocoelic fluid of the mosquitoes parasitised, as has also been expressed by Iyengar (1938). In the mode of feeding on mere haemocoelic fluid, as it emerged now, the species exhibits another character in support of the view that *C. anophelis* represents one of the primitive forms

under the genus, for according to Edwards (1923) it is only the primitive *Culicoides* that feed on the body fluid of insects.

The only evidence of a *Culicoides* feeding in nature on human blood as confirmed by precipitin tests in our observations is afforded by a species which appears to be a new species. We hope to describe the species soon elsewhere.

School of Tropical
Medicine, Calcutta,
November 21, 1957.

P. SEN.
S. K. DAS GUPTA.

1. Das Gupta, S. K. and Ghosh, S. M., *Bull. Calcutta Sch. Trop. Med.*, 1957, 5, 20.
2. Edwards, F. W., *Ann. Trop. Med. Parasit.*, 1923, 17, 19.
3. —, *Rec. Indian Mus.*, 1932, 34, 177.
4. Hill, M. A., *Ann. Trop. Med. Parasit.*, 1947, 41, 55.
5. Iyengar, M. O. T., *Proc. Nat. Inst. Sci. India* 1938, 4, 237.
6. Kieffer, J. J., *Mem. Ind. Mus.*, 1910, 2, 181.
7. Macfie, J. W. S., *Ann. Mag. n. H.*, 1932, 9 (10), 485.
8. Mukerji, S., *Ind. J. Med. Res.*, 1931, 18, 1051.
9. Patel, P. G., *Proc. 4th Entom. Meeting, Pusa*, 1922, 277.
10. Smith, R. O. A., *Ind. J. Med. Res.*, 1929, 17, 255.
11. — and Swaminath, C. S., *Indian Med. Res. Mem.*, 1932, 25, 185.

APPARENT MOLAR VOLUMES AND AGGREGATION OF BARBITURATES

In the course of a study of apparent molar volumes of electrolytes in solution extended to organic ions, it is found that the variation of this property with concentration shows a departure from general behaviour in the case of some of the 5, 5 substituted sodium barbiturates, probably indicative of a change in their state of aggregation in aqueous solution with change in concentration. Precision measurements of the densities of aqueous solutions of the following sodium salts were carried out at various concentrations over the range 0.05 to 0.8 molar at 25°C. by the method of Parker and Parker.¹

(I) 5, 5 diethyl barbiturate. (II) 5-ethyl 5-isopropyl barbiturate. (III) 5-ethyl 5-(1) methyl-butyl barbiturate. (IV) 5-ethyl 5-iso-amyl barbiturate. (V) 5-allyl 5-(1) methyl-butyl barbiturate. The density d_m at molality m is expressed in the form $d_m = d_0 + am + bm^2 + cm^3$ where d_0 is density of water at 25°C. and the values of a , b and c given below hold over the concentration range studied.

TABLE I
Density at 25° C. as a function of molality
coefficients

Solute		a	b	c
I	..	0.07641	-0.01708	0.00503
II	..	0.07599	-0.01413	0.00222
III	..	0.07224	-0.01865	0.00535
IV	..	0.06894	-0.01664	0.00503
V	..	0.07332	-0.01380	-0.00012

Masson has proposed the following relation for the apparent molar volume $\phi(V_2)$ (the difference between the volumes of solution and of solvent containing one mole of solute) which represents the concentration dependence of apparent molar volume of a wide variety of electrolytes²:

$$\phi(V_2) = \phi_0(V_2) + a\sqrt{c}$$

where $\phi_0(V_2)$ and a are constants and c is concentration of solute in mole per litre. The variation in apparent molar volumes of the barbiturates considered here, calculated from the above density data, is represented in figure where $\phi(V_2) - \phi_0(V_2)$ values are plotted against \sqrt{c} . These values show a regular linear rise

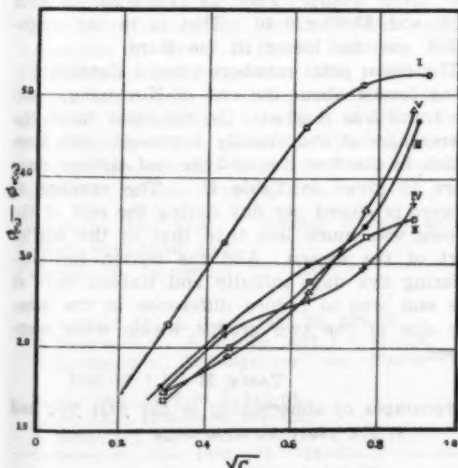


FIG. 1

for all the barbiturates up to about 0.5 molar concentration as fits Masson's equation; but at higher concentrations the curves of I and II tend to level off to a flat while the curves of III, IV and V show a steep rise. This marked increase in apparent molar volumes of the latter three closely resembles the behaviour of

potassium *n*-octoate in solution investigated by Davies and Bury.³ It has been suggested that the lack of affinity between the hydrocarbon chain and water normally leads to the curling up of long chain molecules to minimize hydrocarbon/water interface subjecting them to considerable compression. If the molecules aggregate together at any stage, the surface energy will be lessened and the compressive pressure released causing an increase in the partial volume of the solute.⁴

The marked rise in apparent molar volume indicated by III, IV and V in the region 0.5 to 0.6 molar, viewed in relation to their longer chain substituents in 5, 5 position as compared to I and II seems to bear out the above suggestion and it appears that aggregation of the organic ions of III, IV and V occurs at the concentration indicated.

Chemistry Dept.,
Sri Venkateswara University,
Tirupati, December 24, 1957.

V. R. KRISHNAN.

1. Parker, H. C. and Parker, E. W., *J. Phys. Chem.*, 1925, 29, 132.
2. Masson, D. O., *Phil. Mag.*, 1929, 8, 218.
3. Davies, D. G. and Bury, C. R., *J. Chem. Soc.*, 1930, 2263.
4. Alexander, A. E. and Johnson, P., *Colloid Science*, 1949, 2, Oxford University Press, 687.

PRESENCE OF PROPOLIS IN THE PROTHORACIC SPIRACLES OF *APIS FLOREA* FAB.

WHILE engaged in the study of the respiratory system of some Hymenoptera, the presence of propolis in the prothoracic spiracles of *Apis florea* was detected. Propolis is a resinous material collected by the domestic bees from plants. The bees examined are from two different localities as (i) Mahabaleshwar, and (ii) Kopergaon from Bombay State. The prothoracic spiracles of this species have an operculate closing mechanism as described by Snodgrass² (1956) and Wohlegmuth⁴ (1929). The spiracular opening measures on an average .09 mm. in length and .06 mm. in breadth. The operculum which covers this opening is .14 mm. long and .07 mm. broad. Diameter of the trachea which widens as it leaves the spiracle is approximately .12 mm. The size of the brown mass of propolis based on the measurements of over 30 specimens is .11 mm. in breadth and .1 mm. in length. Judging from the size of the trachea and the size of the propolis it can be readily appreciated that the latter prevents partially, if not completely, the entry of air

into the body of the bee. The presence of propolis in the anterior thoracic spiracles of *Apis florea* is recorded here for the first time. It is interesting in the view of the fact that blocking of the corresponding spiracles with wax in *Apis mellifera* L. results in the total loss of the power of flight according to White³ (1924). He attributed similar effects when the prothoracic spiracles are severely infested with the mite *Acarapis woodi* (Rennie). But in *Apis florea* such a blocking does not seem to have affected their power of flight. This is so because the second thoracic spiracles serve as an alternative mechanism to provide thorough ventilation in the thorax, a region of relatively high carbon dioxide production. Bailey¹ (1954) ignored the second thoracic spiracles of *Apis mellifera* as functionally unimportant because of their exceedingly small size. But in *Apis florea* the second thoracic spiracles are functional and account for the retention of the powers of flight.

Acknowledgement is due to the Ministry of Education, Government of India, for the award of National Research Fellowship. I am indebted to Dr. S. P. Agharkar, Director, M.A.C.S. Laboratory, for extending the necessary facilities and encouragement. The bees were provided through the kindness of Shri K. V. Tonapi of Apicultural Laboratory, Mahabaleshwar.

M.A.C.S. Laboratory, G. T. TONAPI.
Law College Buildings,
Poona-4, December 17, 1957.

1. Bailey, L., *J. Expt. Biol.*, 1954, **31**, 589.
2. Snodgrass, R. E., *Anatomy of the Honey Bee*, Ithaca, New York, 1956, p. 334.
3. White, P. B., *Trans. Roy. Soc. Edinb.*, 1921, **52**, 755.
4. Wohlgemuth, O. E., *Erlanger Jb. Biensch.*, 1920, **7**, 1-46.

THE REGULATION OF PETAL NUMBER

In 1955-56, I examined 76,753 flowers from three plants of *Nyctanthes arbor-tristis*. The gamopetalous flowers are shed nightly and daily collections were made from 26-9-1955 to 11-1-1956. The number of petals varied from 4 to 9 with a high mode at 6. The totals for the three trees are given in Table I.

TABLE I

Total number of flowers with different numbers of petals for three trees

Petal number	4	5	6	7	8	9
Number of Flowers	134	10,975	55,732	9,431	471	8

The mean petal numbers for the three trees were 5.924 ± 0.030 , 6.050 ± 0.030 , and 5.984 ± 0.050 . The second differs significantly from the others. It will be seen that 72.6% of all the flowers had the "standard" number of 6 petals. In most earlier work on variation of petal number^{2,4,5,11} only a minority of flowers had the modal number. Here we clearly have a condition intermediate between the variable sepal number found in *Anemone nemorosa*¹² for example, and the selection where thousands of flowers must be examined before a deviation from the standard is found. My data are superficially comparable with those of Browne² who found that 77.1% of a thousand jellyfish *Aurelia aurita* had the modal number of 8 tentaculocysts. However he was studying a population, whilst I was studying individual plants.

There is clearly a strong but not overwhelming tendency to produce the normal number of six petals. It is reasonable to tabulate the percentage of "abnormal" flowers, i.e., those with a petal number other than six. This is closely related to the standard deviation, but is easier to calculate, and its sampling error does not involve the calculation of the fourth moment. The percentages of abnormality for the three plants were 25.37 ± 0.25 , 26.48 ± 0.24 , and 33.69 ± 0.40 . That is to say, regulation was far looser in the third.

The mean petal numbers altered significantly, being lowest about the end of November. And the trend was marked. On the other hand, the percentages of abnormality increased with time which in the first five and the last sixteen days were as given in Table II. The number of flowers produced per day during the end of the season was much less than that in the earlier part of the season. And the reason for considering five days initially and sixteen days at the end was to reduce difference in the sample size of the two groups which were compared.

TABLE II

Percentages of abnormality in the first five and last sixteen days

Plant	1	2	3
First 5 days	20.93 ± 0.99	23.48 ± 1.44	28.02 ± 1.76
Last 16 days	30.75 ± 2.16	37.24 ± 2.44	37.61 ± 2.30

It will be seen that the regulation was greatly reduced in each case.

These data open up a nearly new field of research, since previous workers have seldom counted enough organs on the same plant to

establish differences in the variation between different plants, still less with time. This applies to the work of Pearson¹¹ and his colleagues on homotyposis. Perhaps the most comparable results are those of Price-Jones¹² on diameters of human red blood corpuscles. Here the coefficients of variation differed between normal individuals and were greatly increased in pernicious anaemia. Attfield¹ subsequently observed significant increase in variance of the diameters of red blood corpuscles of mice in anaemia.

There are, of course, a number of more or less comparable data on the variation between individual members of different clones of Protozoa¹⁰ and of pure lines of mice^{6,9} and the like.^{7,8,13,14} The regularity with which members of a genotype develop has been described as the effect of developmental homeostasis. Here it can be studied on a very large scale.

The work is being extended to the study of other individual plants and other characters. For a character as well regulated as petal number very large samples are needed. Samples of 500 flowers or less would not reveal differences of the order found. Since most work of this kind has been done on herbs, no comparable observations are on record.

I wish to record my sincere thanks and indebtedness to Prof. J. B. S. Haldane, F.R.S., for initiating and suggesting this problem and for his kind help in the presentation of this note. My thanks are also due to Prof. P. C. Mahalanobis, F.R.S., Director, Indian Statistical Institute, for his keen interest and encouragement in this investigation.

Biometric Res. Unit, SUBODH KUMAR ROY.
Indian Statistical Inst.,
Calcutta-35, December 23, 1957.

1. Attfield, M., *J. Genet.*, 1951, **50**, 250-63.
2. Browne, E. T., *Biometrika*, 1901, **1**, 90-108.
3. Co-operative Investigations on Plants—*Ibid.*, 1901-02, **1**, 125-28.
4. —, *Ibid.*, 1902-03, **2**, 145-64.
5. —, *Ibid.*, 1905-06, **4**, 394-426.
6. Gräneberg, H., *Nature*, 1954, **173**, 674-76.
7. Lewis, D., *Ibid.*, 1953, **172**, 1136-37.
8. Mather, K., *Evolution*, 1950, **4**, 340-52.
9. McLaren, A. and Michie, D., *Nature*, 1954, **173**, 698-87.
10. Pearl, R., *Biometrika*, 1906-07, **5**, 53-72.
11. Pearson, Karl (and others), *Phil. Trans.*, 1901, **197A**, 283-379.
12. Price, Jones, C., *J. Path. Bact.*, 1929, **32**, 479-501.
13. Rasmuson, M., *Acta. Zool.*, 1952, **33**, 277.
14. Robertson, F. W. and Reeve, E. K. R., *Nature*, 1952, **170**, 286.
15. Yule, G. U., *Biometrika*, 1901, **1**, 3, 307-09.

PERIODICITY OF WUCHURERIAN MICROFILARIAE IN HUMAN BLOOD

THE present investigation was undertaken to find out if microfilariae of Indian species of filarid worms may also show diurnal incidence. As at present the blood for detection of Indian Wuchererian parasites has to be collected at late hours of night which is rather an inconvenient time if large-scale survey in a rural area has to be conducted. It would solve much of the difficulty if the diurnal blood could provide us some index for determining the extent of filarial endemicity in the country.

With that object in mind, peripheral blood, about 20 c.mm., of certain subjects was collected in the field at different hours of the day and night for study, and the results are summarised in Table I.

TABLE I
Bancroftian microfilariae count at different hours

No. of persons	7 A.M.	7 P.M.	9 P.M.	Mid-night	2 A.M.	4 A.M.
1-6	4*					
7		6	..	24	19	23
8		..	3	..	4	11
9		..	nil	43	..	48
10		..	2	25	..	19
11		..	6	8	16	..
12		24	..	34

* Out of six persons examined, only one showed the parasites at the hour shown: at other hours of the day, 9, 12 and 15, the blood was free.

Blood of six persons (7-12) only could be obtained at different intervals during the night: these patients were either from Bankura (Rajagram), Burdwan (Kotalhat) or Hooghly (Kotrung). The study shows that the microfilariae are most abundant towards midnight. There are two peaks, one at midnight and the other toward early hours of 4 A.M.

In only one patient from Burdwan out of six examined at different intervals during the day the blood proved positive for 7 A.M. sample. The parasites disappeared from the blood after this. Further study around Contai (Midnapore) where malayi type of parasites predominates indicated that the microfilariae are not likely to appear again before 5 P.M., when certain subjects proved positive, but the count was meagre.

The results show that the filarial parasites although not altogether absent in day blood, the rate did not exceed 3% of that observed in night blood from the same locality. Iyengar (1938) observed the same in malayi infection

in Travancore. Observations carried out by Chaudhury and Bhaduri (1955) proved the futility of utilising day blood in assessing filarial incidence of the bancroftian type as well, for they found that nearly 25 to 50 times more blood has to be collected if the parasites are to be detected in day blood, an improbable task in field work. The findings reported here, although in a small series, also lend support to the view that day blood in India should not be depended for working out the filarial incidence; the night blood should form the best means for it.

School of Tropical Medicine,
Calcutta, January 21, 1958.

P. SEN.

1. Iyengar, M. O. T., *Ind. Med. Res. Mem.*, 1938, 5, 78-82.
2. Chaudhury, A. B. and Bhaduri, N. V., *Bull. Cal. Sch. Tr. Med.*, 1955, 3, 53.

ON SAL WOOD EXCAVATED FROM MAURYAN PILLARED HALL, PATALIPUTRA

SAL (*Shorea robusta* Gaertn.) is one of the most important constructional timbers of North India. References to its glories and virtues are found even in ancient Indian literature.^{1,2} But direct evidence about its use in ancient India is surprisingly scanty. We have had occasion to examine a large number of timbers belonging to pre-historic and proto-historic times, but so far we had not come across any sal except in one instance. This was a huge wooden palisade³ discovered during the excavation of ancient Pataliputra near Patna, which has recently been identified by Chowdhury and Ghosh⁴ as sal (*Shorea robusta* Gaertn.). Based on radio-carbon (C14) measurements, Chatterjee and co-workers⁵ have estimated its age as 2115 ± 250 years. This appears to be the oldest record for use of sal.

Recently, we have come across some more material from ancient Pataliputra, evidently belonging to the Buddhist period of Mauryan age. It is reported to belong to wooden beams used as an important fixture of the so-called Mauryan Pillared Hall.⁶ This wood also has now been identified as sal (*Shorea robusta* Gaertn.). Due to the great antiquity of the wood as well as lack of any direct evidence for sal wood having been put to use so many years ago, its characteristics are recorded here briefly.

Due to ageing, the general appearance of the material is not like sal. It is almost dirty grey in colour now, but when split, a shade of greyish-brown colour is noticeable in the inner portion of the wood. The wood is free from any

attack by insect or fungus. However, the exposed portions show the effect of weathering due to natural causes. From the gross features, it appears that the wood comes from a large-sized log, as the specimens examined indicate that they are neither from very near the pith nor from near the periphery. Further, the material does not give any idea of sapwood or transitional heartwood, popularly known as *kucha-pucca* heartwood.⁷ The wood is dense, hard, and when cut with a sharp knife reveals the macroscopic structure remarkably well. It is dull, heavy (specific gravity 0.816), interlocked-grained and medium coarse-textured. The characteristic ribbon-grain effect of sal is not distinct due to loss of colour contrast in alternating layers of tissues.

The visibly intact anatomical structure as seen under the microscope agrees in all essential details with that of fresh sal wood. Sections, when stained with Haidenhein's hæmatoxylin and safranin O, however, are not very bright due to rather weak response to safranin. This indicated to some extent the visible effect on lignin, particularly of the thick-walled fibres. Further, the material could be cut with comparatively less difficulty than sal of today, suggesting possible changes in the chemical nature of the cell-walls of various tissues. The wood is typically diffuse-porous and is characterised by indistinct growth marks, moderately small to moderately large vessels, 56-252 μ in diameter and most heavily plugged with tyloses (Figs. 1, 2); vertical gum ducts often arranged in tangential bands and sometimes found choked with tylosoids or tyloses-like structure; parenchyma conspicuous round the vessels and gum ducts, sometimes extending sideways across the rays; diffuse parenchyma scanty; fibres retain their shape remarkably well, showing dense, compact, very thick-walled structure with very much reduced lumen (Fig. 1); rays filled with heavy deposits, usually 3-5 cells and up to 84 μ in width, and up to 54 cells or 1,008 μ in height, almost homogeneous (Fig. 2).

This relic is of great interest for more than one reason. It gives us some idea of the knowledge, people of the Mauryan age possessed regarding the properties and uses of timber. As one of the most durable timbers in contact with soil, the reputation of sal is well known to us today. This special property of sal must have been known to them also as judged by their efficient use of this timber even according to modern standards. Further, a reference to the photomicrographs will at once reveal a very uniform anatomical structure of sal of fairly high quality, having moderately few vessels,

dense tracts of thick-walled fibres, and proportionately less of parenchyma (Fig. 1). Moreover the wood represents a mature portion of the heartwood having vessels completely packed with tyloses impeding the entry and growth

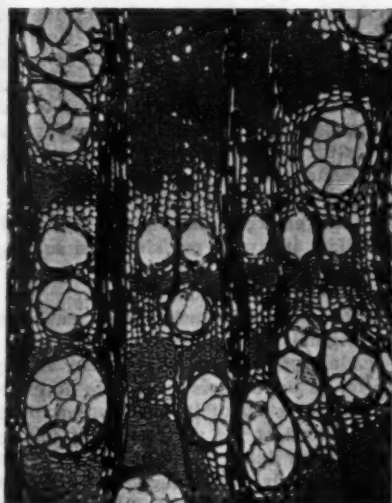


FIG. 1. Transverse section of the wood from Pataliputra. Note heavily tylosed vessels, dense fibrous tissue and a tangential row of gum ducts in the middle of the photo ($\times 65$).



FIG. 2. Tangential section to show well preserved rays, parenchyma and vessel. Note thick and dark strands of fibres on the left and a vessel choked vertically with tyloses on the extreme right ($\times 65$).

of insects and fungi in the wood (Figs. 1, 2). From this it will not be unreasonable to suppose that the people of this civilization knew what constituted the best sal from the point of view of strength and durability.

Observations on sal have shown that timbers of mature trees even after being used for 25 years still remain strong and durable. The specimens from Pataliputra, however, indicate a very high durability of heartwood of sal not so far recorded. The good state of preservation of the wooden palisade which remained in the ground for over 20 centuries at Pataliputra led Purushottam and co-workers⁸ to conclude that these must have had a preservative treatment. At that time, the identity of the timber used was not at all known to them. Taking into consideration the fact that heartwood of sal is not amenable to any treatment, their conclusion regarding preservative treatment of the wooden palisade would appear to be rather speculative. Moreover, microscopic examination did not show any evidence of such a treatment. From our experience of the study of ancient woods, another point which may be of interest is recorded here. It has been noticed from various excavations made so far that just as teak (*Tectona grandis* Linn. f.) has been a predominant timber in important fixtures of Buddhist monasteries and caves and other temples in South-West India, sal has been characteristic in North India. This would mean that out of the large number of species available in the forests of India, the ancients must have had wealth of experience to select the most important timbers in South and North India.

Grateful acknowledgement is due to Shri V. K. Mishra, M.A., K. P. Jayaswal Research Institute, Patna, for sending the materials for study and supplying some field notes concerning the excavation.

Forest Res. Inst.,
Dehra Dun,
December 20, 1957.

S. S. GHOSH.
KRISHNA LAL.

1. Shamasastri, R., *Kautilya's Arthashastra*, 2nd Ed., 1928.
2. Majumdar, G. P., *Some Aspects of Indian Civilization*, 1938.
3. Smith, V. A., *Asoka, the Buddhist Emperor of India*, 3rd Ed., 1920.
4. Chowdhury, K. A. and Ghosh, S. S., *Indian Woods*, 1 (in press).
5. Chatterjee, S. D. and Co-workers, *Sci. and Cult.*, 1938, 20, 615-17.
6. Ghosh, A., *Indian Archaeology*, 1954-55—A Review, 1954.
7. Chowdhury, K. A., *Ind. For. Bull.*, 115, 1942.
8. Purushottam, A. and Co-workers, *Ibid.*, 198, 1953.

**XYLEBORUS DISCOLOR BLAND., AS A
PEST OF CACAO**

IN recent years attempts are being made to increase the area under Cacao—*Theobroma cacao* L. in this country with a view to reduce the import of this popular beverage. Beeson (1919) has recorded a few wood-borers, viz., *Chrysobothris bicolor* F., *Dihamus rusticator* Germ., and *Xylothrips flavipes* Ill., as pests of this crop in India. Ramakrishna Ayyar (1919) has observed that *Planococcus* (*Pseudococcus*) *citri* Risso, is the most important pest in Madras. Recently the authors had occasion to notice a bad incidence of ambrosia beetles' (Scolytidae) attack, leading to the gradual wilting of the affected trees in the Nilgiris.

Three species belonging to the genus—*Xyleborus*—are concerned in the damage. One has been determined as *Xyleborus discolor* Bland. by the Forest Entomologist, Dehra Dun. The other two appear to be new and will be described by him elsewhere. In general, the beetles are about 2 mm. in length, short and cylindrical, pronotum testaceous and elytra dark brown to testaceous. The grubs are creamy white in colour. They tunnel inside the stems and confine their activities mostly to young branches. As a result of the damage caused, the leaves begin to fade and ultimately the affected branch dries up.

Xyleborus discolor Bland. was first described by Blandford (1898) from specimens collected on Cacao in Ceylon and forwarded for determination by Green. This species is polyphagous and attacks a number of plant species, viz., *Hevea* (rubber), *Albizia*, *Lonicera caprifolium*, *Cassia multijuga*, *Tephrosia candida*, *Coffea arabica*, and several others.

The above observations were made under a scheme financed by the Indian Council of Agricultural Research.

I. P. JANAKI.
T. S. MUTHUKRISHNAN.
K. R. NAGARAJA RAO.

Entomological Division,
Agricultural College and
Res. Institute,
Lawley Road P.O.,
Coimbatore, January 4, 1958.

1. Ayyar, Ramakrishna, T. V., *J. Bombay Nat. Hist. Soc.*, 1919, 26 (2), 621-28.
2. Beeson, C. F. C., *Indian Forester*, 1919 (a), 45 (2-3), 49-56, 139-53.
3. —, *Ibid.*, 1919 (b), 45 (9), 488-95.
4. Blandford, F. H., *Trans. Ent. Soc.*, London, 1898, Pt. IV, 423.

**STEGANA LATERALIS V.D. WULP
AS A PEST OF SESBANIA
GRANDIFLORA**

Sesbania grandiflora or 'Agathi' is a leguminous crop grown largely as a standard for betel vine (*Piper betel*) in South India. During the course of observations made at Podanur (Coimbatore District) on the biology and control of the stem weevil *Alcidodes bubo*, F., a serious pest of this crop, the authors had occasion to notice certain maggots boring into the tender shoots of grown-up plants causing a gradual wilting of the affected ones. These were collected and kept under observation in the laboratory. The adults that emerged belonged to the family *Drosophilidae* and were got identified as *Stegana lateralis* v.d. Wulp by the kind courtesy of the Director, British Museum, London. This fly was seldom seen to attack young seedlings.

The original description of this species has been made from specimens collected at Ceylon and so far as the authors are aware no information is available about its distribution. This is the first record of the occurrence of this fly as a crop pest in India. The adult is an active, dull yellowish fly measuring 3.5 mm. in length and the maggots are about 4.5 mm. in length when full grown and are pale white in colour. Pupation takes place inside the stem and the pupa is about 3.7 mm. long and reddish brown in colour. The adults emerge in 4 to 5 days from the pupae. The damage done by this fly to the crop was noted to be very appreciable and, if neglected, this may become a major pest of this crop in betel vine gardens. Further studies are in progress.

Division of Entomology, T. R. SUBRAMANIAN.
Agric. College and K. R. NAGARAJA RAO.
Res. Institute,
Coimbatore, December 21, 1957.

**ON THE ANTHERIDIUM IN
CHARACEÆ**

THE antheridium in the different Characeæ is generally believed to have a uniform structure and development (see Fritsch, 1935; Smith, 1955). The writers have studied the antheridia in two species of Chara, *C. corallina* Willd., and *C. zeylanica* Willd.

The antheridium in *C. corallina* is very similar in structure to those already described in the other Characeæ. The mature antheridium has eight shield cells (octoscutate) and each shield (a) carries a manubrium (b), and a primary capitulum cell (c). The cell that is

WULP
A

eguminous
betel vine
the course
Coimbatore
of the stem
is pest of
to notice
er shoots
al wilting
ected and
tory. The
he family
as *Stegana*
sy of the
This fly
dlings.
pecies has
at Ceylon
informa-
This is
his fly as
an active,
in length
in length
in colour.
and the
sh brown
o 5 days
y this fly
ppreciable
a major
Further

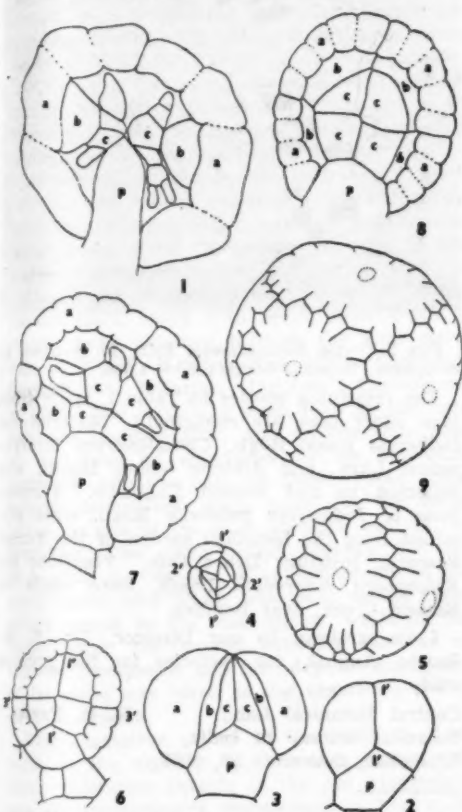
MANIAN.
AJA RAO.

N

araceae is
structure
Smith,
antheridia
a Willd.,

very simi-
described in
antheridium
and each
, and a
l that is

to form the antheridium first divides transversely cutting off a lower cell, the pedicel cell (p), and then the upper cell by two vertical divisions (planes 1'-1', 2'-2') form four quadrately arranged cells; each of these four cells divides transversely (plane 3'-3') resulting in an eight-celled structure. Each of these octads undergoes 2 periclinal divisions ultimately leading to a globular structure of 24 cells arranged in three concentric layers (Text-Figs. 6, 8).



TEXT-FIGS. 1-5. *Chara zeilanica*. Figs. 1-3. Vestibular sections of the antheridia; Fig. 4. Cross-section of the antheridium at stage shown in Fig. 3. Fig. 5. External view of the entire antheridium.

TEXT-FIGS. 6-9. *Chara corallina*. Figs. 6-8. Vestibular sections of the antheridia. Fig. 9. External view of the entire antheridium. (1'-1', 2'-2', 3'-3'-planes of division; a = shield cell; b = manubrial cell; c = primary capitulum cell; p = pedicel cell.)

Magnifications: FIGS. 1, 5, 7, $\times 290$.

FIGS. 2, 3, 8, $\times 330$.

FIGS. 4, 6, 9, $\times 150$.

The outermost become the eight shield cells, the innermost become the primary capitulum cells and the middle eight ultimately form the eight manubria. The pedicel cell elongates and protrudes into the interior of the antheridium (Text-Fig. 7). Thus a fully mature antheridium, in a transverse section, shows 4 shield cells, 4 manubria and 4 primary capitulum cells and 4 similar sets together with the pedicel cell in the vertical section.

In a collection of *Chara zeilanica* from S. Africa, Groves (1931) has reported the presence of four shield cells only (quadriscutate). This paper, however, has been overlooked or not taken notice of by most writers (see however, Zaneveld, 1940, p. 206). Tuttle (1924) has earlier pointed out a similar condition in an unidentified species of *Nitella*. Sundaralingam (1954) has worked out the developmental morphology of *C. zeilanica*. But he apparently overlooked this point. Those preparations as well as abundant fresh material have been restudied. The present study has shown that Groves' observations hold good with regard to the South Indian plants too. Up to the formation of the four quadrately-arranged cells, the development of the antheridium is the same as in *C. corallina*. That is, divisions in planes 1'-1' and 2'-2' take place but the transverse division in plane 3'-3' does not take place (Text-Fig. 2). Thus the octad stage is not formed. These four quadrately arranged cells undergo two periclinal divisions and as a result, the ultimate structure is made up of 12 cells only, arranged in three concentric layers (Text-Figs. 3, 4); the outermost four develop into the four shield cells (a), the innermost into 4 primary capitulum cells (c) and the middle into the 4 manubria (b). Thus in the mature condition, a transverse section of the antheridium reveals three concentric layers (Text-Fig. 4); and in a vertical division of the antheridium, one finds only two shield cells, 2 manubria and 2 primary capitulum cells, together with the pedicel cell (Text-Fig. 1). Thus *C. zeilanica* has a quadriscutate antheridium.

The shields also look different in surface view. In the case of the octoscutate antheridia, the shield cells are nearly triangular (Text-Fig. 9), whereas in the quadriscutate condition, they are roughly rhomboidal or lozenge-shaped (Text-Fig. 5). It will be interesting to study as many Characeae as possible to find out the condition of the antheridium and the mode of its development.

The writers are grateful to Dr. T. V. Desikachary for his kind help and suggestions.

University Botany Lab., V. S. SUNDARALINGAM.
Madras; and K. J. FRANCIS.

Botany Dept.,
University of Saugar,
Sagar, January 24, 1958.

1. Fritsch, F. E., *The Structure and Reproduction of Algae*, Cambridge, 1935, 1, 791 pp.
2. Groves, J., 'On the antheridium of *Chara zeylanica* Willd.', *J. Bot.*, 1931, 69, 97-98.
3. Smith, G. M., *Cryptogamic Botany*, McGraw-Hill, New York, 1955, 1, 546 pp.
4. Sundaralingam, V. S., 'The developmental morphology of *Chara zeylanica* Willd.', *J. Ind. bot. Soc.*, 1954, 33, 272-97.
5. Tuttle, A. H., 'The Reproductive cycle of the Characeae', *Science*, n.s., 1924, 60, 412-13.
6. Zaneveld J. S., 'The Charophyta of Malaysia and adjacent countries', *Blumea*, 1940, 4 (1), 1-223.

CHROMOSOME NUMBERS OF SOME DICOTYLEDONS

SOME new chromosome numbers were determined by me in the course of systematic studies on the angiosperms. The determinations (Table I) were based on meiotic divisions in anthers prefixed in acetic alcohol and squashed in aceto-carmin.

TABLE I

Species	Family	Haploid Chromosome No.
<i>Clerodendrum infortunatum</i> Linn.	Verbenaceae	26
<i>Albizia lebbek</i> Benth.	Mimosaceae	13
<i>Indigofera pulchella</i> Roxb.	Papilionaceae	8
<i>Dalbergia sissoo</i> Roxb.	do.	10
<i>Rhizophora mucronata</i> Lamk.	Rhizophoraceae	18
<i>Croton bonplandianum</i> Baill. (<i>Croton sparsiflorus</i> Morong) ³	Euphorbiaceae	10 (vide Fig. 1)
<i>Alstonia macrophylla</i> Wall.	Apocynaceae	11

In the list given above (Table I) all except two species are indigenous or naturalised. The two exceptions are *Croton bonplandianum* Baill. and *Alstonia macrophylla* Wall. *Croton bonplandianum* is a native of South America, introduced into Bengal about the year 1898.⁶ Material for the present observations on this species was collected at Lucknow where it is abundant in waste places. The plant is not mentioned by Duthie⁴ and is a recent introduction to U.P. and the Upper Gangetic Plain.⁵

Alstonia macrophylla is a native of Malaya but has been planted in various parts of India. Material for study, was obtained from the National Botanical Gardens, Lucknow.

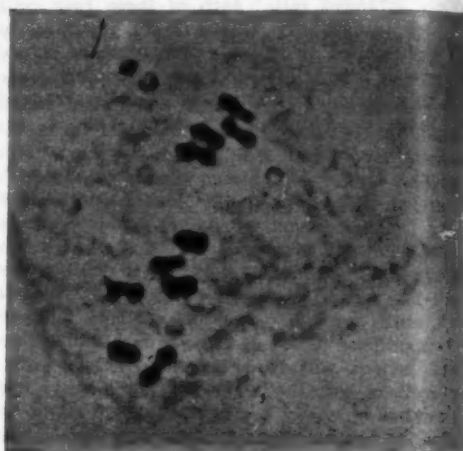


FIG. 1. *Croton bonplandianum* Baill. 10 bivalents at metaphase I in pollen mother cell, $\times 1,500$.

The remaining species in Table I, apart from their other uses, are medicinal.² Material for *Dalbergia sissoo* Roxb., *Clerodendrum infortunatum* Linn., and *Albizia lebbek* Benth. was collected in and around Lucknow. Flowerbuds of *Indigofera pulchella* Roxb. were obtained from the botanical garden of the Forest Research Institute, Dehra Dun. Fixations for *Rhizophora mucronata* Lamk. were made at Bassein Creek, near Bombay.

I am grateful to our Director, Dr. E. K. Janaki Ammal, for facilities for the present study.

Central Botanical Lab., R. P. PATIL.
Botanical Survey of India,
Allahabad, December 26, 1957.

1. Benthall, A. P., *The Trees of Calcutta and Its Neighbourhood*, Calcutta, 1946, 312.
2. Chopra, R. N., Nayar, S. L. and Chopra, I. C., *Glossary of Indian Medicinal Plants*, New Delhi, 1956.
3. Croizat, L., *J. Bombay Nat. Hist. Soc.*, 1940, 4, 573.
4. Duthie, J. F., *Flora of the Upper Gangetic Plain*, Calcutta, 1915, 3, Part 1.
5. Joshi, A. C., *Curr. Sci.*, 1934, 2, 344.
6. Mayuranathan, P. V., *The Flowering Plants of Madras City and Its Immediate Neighbourhood*, Madras, 1929, 267.

**LATERAL BUD DEVELOPMENT IN
'PEARL MILLET'—*Pennisetum*
typhoides STAPP ET HUBBARD,
IN RELATION TO ITS FLOWERING**

BRANCHING and other abnormalities in the reproductive spike in cereals and other plants are on record from early days. The earlier work has been reviewed elsewhere.¹ A comprehensive review of the more recent observations on the subject has also appeared lately.² Abnormalities in the reproductive spike in *Pennisetum typhoides* have also been reported by some workers.^{3,4}

During the course of extensive investigations on growth and development of a number of millets carried out in this laboratory, some interesting observations were recorded on the development of lateral buds and their flowering. As the results are interesting and throw light on the relationship between growth and development, these are briefly reported in the present communication.

The seeds of *Pennisetum typhoides* strain Cumbu Co. 1, along with seven other types of millets were obtained through the kind courtesy of Mr. P. Krishna Rao, Millet Specialist, Agricultural Research Institute, Coimbatore, in 1949. The seed was sown both in the field and pots in June 1952, and records were kept of the dates of emergence of the individual branches and the ears on them. From these records calculations were made for the vegetative periods of the main shoot as well as the branches. The mean period between the day of sowing and the day of ear-emergence of the main shoots of 5 plants was taken as the vegetative period of the main shoots, while on the other hand, the period between the day of branch emergence and the day of emergence of its spike was taken as the vegetative period of that branch.

The vegetative period of the main shoot as well as the number of branches along with their vegetative periods in the pot experiment are diagrammatically represented in Fig. 1. In this figure the vertical line in the middle marked with 'M' represents the main shoot, while those on the sides represent the branches. The branches emerging from the axils of the leaves on the main shoot are referred as 'primary branches'. These are drawn with thick double vertical lines and are marked with numerals to denote the order of their emergence on the main shoot. The branches that arise in the axil of the leaves of the primary branches are referred as 'secondary branches' and are drawn with thin double vertical lines. These have

been marked with a letter to indicate the order of their emergence. Thus there are two branches that arise from the primary branch 4. The first of these two that emerges from the

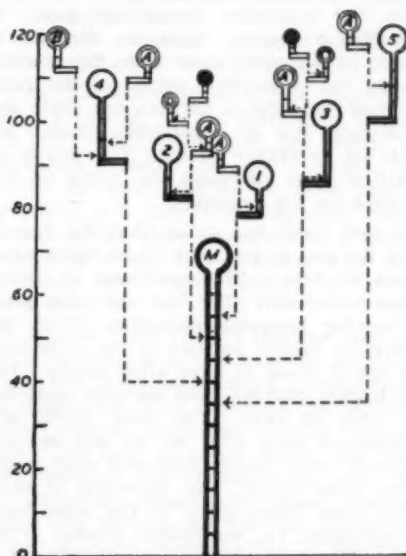


FIG. 1. Diagrammatic representation of plants showing number of branches as well as lengths of the vegetative periods of the main shoot and the branches in *Pennisetum typhoides*.

upper node is marked 'A' while the second one emerging from a node lower to it is marked 'B'. The period of branch emergence, i.e., the period (in days) elapsing between the date of sowing and the emergence of a branch is indicated by the horizontal double line which is placed at such a distance from the abscissa that it gives the time of branch emergence from the date of sowing. The position on the main shoot (or the primary or secondary or tertiary branch) from which this branch emerges is indicated by an arrow that terminates below a dotted line which connects it with the main shoot in the case of primary branches and a primary, secondary or tertiary branch in the case of secondary, tertiary or further branches respectively. This position is in relation to the inflorescence (of the main shoot or the branch as the case may be) which is represented in each case by a circle that terminates the upper end of the vertical line. While the inflorescences of the main shoot and primary branches are represented by circles with single lines, those of secondary branches are represented by circles with double

lines. The inflorescences of tertiary branches are shown by circles with triple lines and the blackened circles represent the inflorescences of the branches that emerge from the tertiary branches. The length of each vertical line represents the vegetative period (in days) of that particular branch. Thus the distance of the circle of the main shoot from the abscissa represents the vegetative period of the main shoot while the distance between the circle and the horizontal line of a particular branch represents its vegetative period. The marks on the vertical lines represent the nodes on the main shoot or the branches.

It is seen from this figure that the emergence of the ear of the main shoot takes place in about 65 days. The emergence of lateral branches occurs only after that and takes place in a regular basipetal succession. Thus, the first primary branch appears in the node next to the apical spike 78 days after sowing. The second branch emerges from the next node below it after 82 days. The third, fourth and fifth branches arise after 85, 90 and 99 days respectively from fourth, fifth and sixth nodes counting from above. The flowering of these branches also takes place in the same basipetal succession, i.e., the branch nearest to the apical spike showed ear-emergence first followed by the second below it and so on. The length of the vegetative period varies in these branches as is indicated by the length of the vertical lines representing them. Thus the vegetative period is only 6 days in the case of first branch and increases to 16 days in the fifth branch. As a result of this the length of the branches increases from top downwards. The first branch is, thus, very short and the lower ones are longer than this. The number of nodes in the upper 3 branches is only 2 while in the fourth branch it is 3 and increases to 4 in the fifth branch. While the emergence of secondary branches on the lower primary branches with more than two nodes takes place in basipetal manner, as is the case with primary branches on the main shoot, each one of the upper primary branches (having two nodes each) shows one secondary branch which arises in the axil of the leaf next to the boot leaf. The emergence of this branch takes place after the emergence of the ear of the primary branch on which these are borne. Like the upper primary branches these secondary branches also consist of only two nodes so that there is only one tertiary branch that emerges from the lower of these two nodes in each case. In many cases further branching of these tertiary

branches takes place and since all these branches arise from the lower of the two nodes in each case, as many as 4-6 branches appear to arise from the same node sometimes (Fig. 2). It

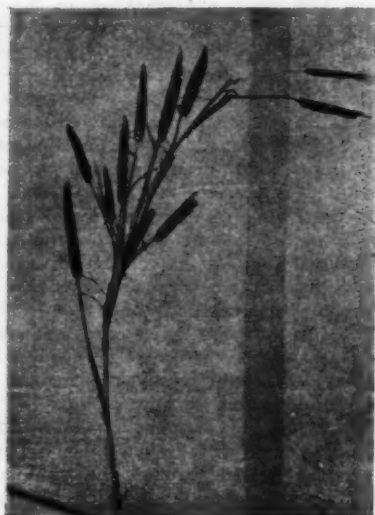


FIG. 2. The emergence of primary, secondary, tertiary and further branches in *Pennisetum typhoides*. A number of branches appear to arise from the same node in some cases.

is, however, interesting to note that the emergence of a branch takes place only after the emergence of the ear of the primary, secondary or tertiary branch on which that particular branch is borne. These results, thus, clearly show that the pattern of branching in the case of *Pennisetum typhoides* is somehow related with the developmental process of this plant. Similar effects of the developmental process on the pattern of branching in the case of *Panicum miliaceum* have been reported elsewhere.^{5,6}

The other peculiarities about the axillary spike development were that in many cases there was complete sterility and also the form of the spike varied considerably, even on the same plant. The sterility of these spikes is of special significance. The pollen fertility has been found to be considerably influenced by differential photoinductive treatments.^{7,8} It appears, therefore, that the sterility was most probably due to unfavourable photoperiod in which this variety of bajra was growing at Delhi. This suggests that its gametogenetic phase was adversely affected. The very fact that spikes have been formed on almost all the nodes signifies that this is not a case of re-

branches
s in each
r to arise
2). It

versal in phasic development but a disarrangement in some of the developmental phases. Further discussion on this subject is reserved for a later date when the full data will be presented.

Dept. of Botany,
University of Delhi,
Delhi-8, December 20, 1957.

K. K. NANDA.
J. J. CHINYOY.

1. Bose, R. D., *Ind. J. Agric. Sci.*, 1935, **5**, 155-64.
2. Chinoy, J. J. and Nanda, K. K., *Ibid.*, 1946, **16**, 390-99.
3. Rangaswamy Ayyangar, G. N., *et al.*, *Curr. Sci.*, 1935, **4**, 237-38.
4. Chandrasekharam, S. N. and Daniel Sundararaja, D., *Ibid.*, 1950, **19**, 92-93.
5. Nanda, K. K., Grover, R. and Chinoy, J. J., *Pyton.*, 1957, **5**(2), 97-108.
6. Nanda, K. K., *Ibid.*, 1957, (in press).
7. — and Chinoy, J. J., *Curr. Sci.*, 1945, **14**, 241.
8. —, *Plant Physiol.*, 1957, **32**, 163-69.

THE STUDY OF SEED CONTENT AND FRUIT SHAPE IN RELATION TO REMOVAL OF STIGMA IN *LUFFA* SPECIES

The gynoecium in *Luffa* species is tricarpeal, syncarpous and trifid. The three stigmas and carpels are radially arranged. On maturity, the fruits have three chambers containing seeds, separated from one another by thick fibrous network and thus not allowing any intermixing of the seeds. During the course of an investigation on the floral biology of *L. acutangula*, Roxb. and *L. cylindrica* (Lour.) Roem., the pollen distribution among the three stigmas was studied in relation to radial symmetry. The experiment consisted in bagging of the pistillate flowers a day before anthesis, and

pollinating them in the following three ways, almost on similar lines, as followed by Mann (1943) in water melons:

- (i) Pollen applied to all the three stigmas.
- (ii) One stigma removed and the rest two pollinated.
- (iii) Two stigmas removed and pollen applied to the third one.

Care was taken to avoid the application of pollen grains on the cut surfaces in treatments two and three. In the first and second set of treatments, nearly all the treated female flowers set fruits but in the third case there was about 15% mortality. The seeds contained in each of the three chambers of a fruit corresponding to each treated stigma were counted separately and their number is given in Table I.

It is clear from Table I that the seed chamber corresponding to the removed stigma, contained few seeds, while those corresponding to the unremoved ones, to which the pollen was evenly applied, contained a large number of seeds. In case of fruits where two stigmas were removed, the corresponding seed chambers contained considerably lesser number of seeds. The development of few normal seeds in the chambers corresponding to the stigmas, which had been removed, was due to the fertilization of the ovules by pollen tubes diverted from the stylar canal of intact stigma. This becomes more evident in view of nearly equal distribution of seeds in all the three chambers of the fruits formed as a result of the first treatment (Table I). This may be due to equal number of pollen tubes travelling down the stylar canal and fertilizing an equal number of ovules.

TABLE I

The effect of stigma removal on seed distribution in fruit chambers of *Luffa* species

		Average seed content per fruit in								
Material	Type	Control			One stigma removed			Two stigmas removed		
		1st chamber	2nd chamber	3rd chamber	1st chamber	2nd chamber	3rd chamber, stigma cut	1st chamber	2nd chamber, stigma cut	3rd chamber, stigma cut
<i>L. acutangula</i> ..	T 5	50.4	38.4	32.6	14.2	11.6	5.6	42.4	13.0	9.8
	T 9	75.3	70.6	68.3	57.3	52.0	16.3	64.6	16.6	10.6
<i>L. cylindrica</i> ..	T 20	258.6	246.8	227.8	195.4	178.8	54.2	222.6	56.6	39.6
	T 29	132.6	125.0	114.3	129.6	106.3	48.3	141.0	59.0	33.0
	T 31	88.0	79.3	75.0	86.0	83.3	19.0	76.6	19.0	13.3

Large differences in seed chambers observed in the above table are associated with differences in the fruit size. The fruit shape, however, appears to be influenced more by relative number of seeds per chamber than by total number of seeds. A marked variation in shape was noticed in the long-fruited strains of T5, T9 and T31. The side on which the stigma was intact showed a normal surface but the treated side showed a depressed or curved surface. The depression happened to be more in the treatments in which two stigmas were removed (Fig. 1).

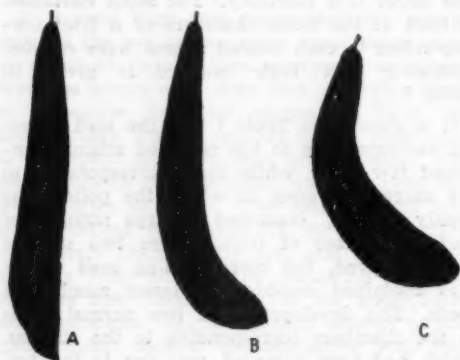


FIG. 1. A, Normal; B, One stigma cut; C, Two stigmas cut.

It is, thus, clear that the removal of one or two of the three stigmas prior to pollination, and the consequential inequality of pollen distribution on the respective stigmatic surfaces, results in the distortion of normal fruit shape in the above two species of *Luffa*.

Govt. Horticultural Res.

S. N. SINGH.

Inst., Saharanpur,

U.P., December 24, 1957.

1. Mann, L. K., "Fruit shape of water melons as affected by placement of pollen on stigma," *Bot. Gaz.*, 1943, 105, 257-62.

PRIMITIVE FEATURES IN THE ALIMENTARY CANAL OF *GADUSIA CHAPRA* (HAMILTON)

MORPHO-HISTOLOGICAL studies of the digestive tube of fishes have been worked out in most of the groups of Teleostei. It is rather strange that Clupeidae, being the most primitive family, has received very scanty attention from the Ichthyologists. But for the stray works of Stirling (1884)¹ on herring and on gizzard shad, *Dorosoma cepedianum* by Wier and

Churchill (1945),² no detailed literature exists. With this view the present work has been taken up which has shown some interesting and primitive features.

Depending upon the presence and absence of the taste buds, the fishes are supposed to belong to a group which apply their sense of taste in selecting their food or to another group which are blind-feeders. In case of *Gadusia chapra* (Hamilton), the taste buds are entirely wanting and one would naturally assume it to be a blind-feeder. But the study of the food contents in the stomach indicates that it is strictly a plankton-feeder and accordingly, as has been shown by Al-Hussaini (1947),³ the gill rakers are very closely set on the branchial arches. The rakers are very well adapted for straining microscopic plankton from the water in a sieve-like fashion. This shows that the fish does apply some sense in selecting its food.

Over the dorsal surface of the snout, there is a rich concentration of nerve cells. Such concentrations are also present on the epithelium of the lip, tongue, pharynx and the oesophagus. The intensity of the concentration is highest on the lip (Fig. A). The histological

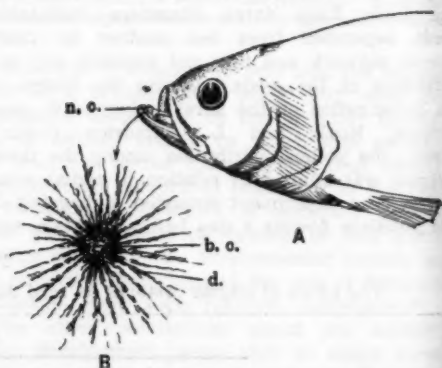


FIG. A. Lateral view of the head of *Gadusia chapra* to show the distribution of the nerve cells over the snout, lip and the tongue.

FIG. B. One of the nerve cells under microscope (low power).

[b.c. = cell body; d. = dendrites; n.c. = neuroglia cells.]

study shows that these nerve cells are present just below the mucosal epithelium, starting from the lip to the oesophagus. These cells are neuroglia cells which together with their processes, the dendrites, constitute the ground-substance in which the nervous elements lie embedded (Fig. B).

are exists.
een taken
and pri-

bsence of
ed to be-
sense of
her group
Gadusia
e entirely
ssume it
y of the
es that it
ordingly,
47),³ the
he bran-
l adapted
from the
ows that
ecting its

ut, there
s. Such
e epithe-
the oesoph-
ration is
stological

A very simple method had been adopted to demonstrate these nerve cells. A portion of the epithelium had been taken out from the anterior part of the buccal cavity (lower jaw) and the tongue with its supporting cartilage. They were treated with 10% KOH for about 15 minutes. Then they were washed thoroughly in water, dehydrated, cleared and mounted without staining.

Clupeidae is the most primitive family of Teleostei and these nerve concentrations show a very interesting and primitive stage in the origin of the taste buds. In *Gadusia chapra* (Hamilton), the nerve concentrations are there on the lips, tongue, pharynx and oesophagus but the taste buds have not yet originated and become specialised in the mucosal epithelium. These nerve cells are responsible for carrying the gustatory sense to the brain and hence the fish is not a blind-feeder. Fishes are known where the taste buds occur from the buccal cavity to the oesophageal region. Further work is in progress and the detailed account will be published elsewhere.

Zoology Dept., P. N. SRIVASTAVA.
University of Allahabad,
January 15, 1958.

1. Stirling, W., *Rep. Scot. Fish.*, 1884, 2, 81.
2. Wier, H. C. and Churchill, E. P., *Proc. S. Dakota Acad. Sci.*, 1945, 25, 334.
3. Al-Hussaini, A. H., *Jour. Morph.*, 1947, 80, 251.

ROOTS ON AN INTERNODE IN SUGARCANE

WHILE the occurrence of secondary meristem in internodal region resulting in the development of callus of various shapes and sizes was noted in sugarcane by some workers,^{1,2} others^{3,4} were able to produce such tissues artificially in several cases. Formation of roots on a portion other than the rootzone in sugarcane is extremely rare although in coconut they were mentioned to have appeared on old stems.⁵ The abnormality reported in this note was found in a stalk of Co. 302 at the Sugarcane Sub-Station, Karnal, in December 1949, and is preserved at the Sugarcane Breeding Institute, Coimbatore.

In this interesting case, 24 roots, inclusive of rudimentary ones, were seen developing from the callus on one of the internodes (Figs. 1a, b). Coming out as they did from a small area, they were overcrowded and irregularly formed as against those usually formed in root zones from 50-75 root eyes which are arranged in

regular rows. While some of these internodal roots attained a length of 5 cm. there was no



FIG. 1

Roots from the internode of Co. 302 (Photograph and pen and ink sketch of the same specimen).

formation of roots at either nodes immediately below or above the callus.

Central Coconut

T. A. DAVIS.*

Res. Station,
Kayangulam (Kerala),
September 27, 1957.

* Previously working at the Sugarcane Substation, Karnal.

1. Barber, C. A., *Memoirs Dept. Agric. (Madras), Bot. Series*, 1919, 9 (2), 58.
2. Martin, J. F., *Proc. Internat. Soc., Sugarcane Technologists' 4th Cong.*, 1932.
3. —, *Ibid.*, 6th Cong., 1938, 461-67.
4. Munzik, T. J. and LaRue, C. D., *Science*, 1952, 116, 589-91.
5. Menon, K. P. V., Davis, T. A., Anandan, A. P. and Pillai, N. G., *Indian Coconut J.*, 1955, 8, 79-91.

CYTOLOGY OF *DIPLAZIOPSIS*
JAVANICA

Diplaziopsis C. Chr. (= *Allantodia* Wallich) is a problematic genus amongst leptosporangiate ferns. It has undergone many systematic changes. Bower¹ treats it provisionally along with his 'Asplenoid Ferns'. Christensen² revised his opinion to give it a generic status and treats as 'a group of ferns with areolate veins' under *Diplazium*. Ching³ and Dickason⁴ place the genus in tribe Athyriæ of Family Aspleneaceæ. Copeland⁵ includes *Diplaziopsis* in his Family Aspidiaceæ and accords it a position near *Athyrium* just at the end of the family. Holttum⁶ in presenting a new classification of ferns does not refer to this genus.

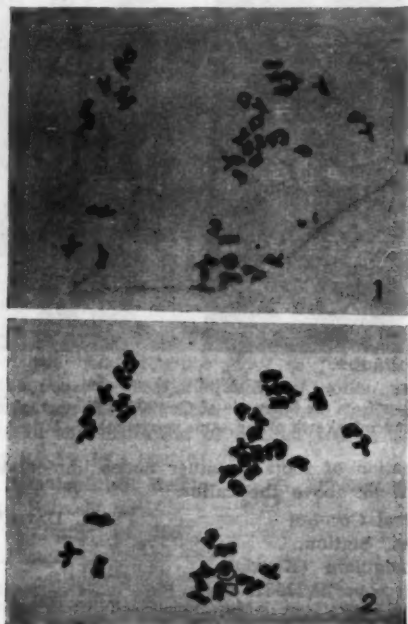


FIG. 1. Spore mother-cell of *Diplaziopsis javanica* showing $n = 41$, $\times 970$.

FIG. 2. Explanatory diagram to Fig. 1, from a bleached photograph, $\times 970$.

Diplaziopsis is essentially an old world genus with only two living representatives, namely, *D. javanica* (Bl.) C. Chr. and *D. cava-*

leriana (Christ) C. Chr.^{3,5} The former is a type species of the genus and the latter is a native of China only.³ While the detailed studies on anatomy, development of sorus and gametophytes are in hand, the present report aims to record the chromosome number of *Diplaziopsis javanica*. The basic number for the genus is unrecorded so far.

The species is reported from Eastern Himalayas, South India and Burma. Material for the present study was collected from Darjeeling area from different localities during the months of July and August. Usual acetocarmine squashes were prepared after fixing in Carnoy's Fluid for 24-48 hours. During meiosis 41 bivalents were unmistakably counted in several spore mother-cells of specimens from different localities (Figs. 1-2). The divisions are regular resulting in 64 well-filled viable bilateral spores with distinct perisporium.

It is noteworthy that to whatever family *Diplaziopsis* has been assigned, it has always been grouped with *Athyrium* and *Diplazium*. Furthermore, *Diplazium* has been united with *Athyrium* by both Copeland⁵ and Holttum,⁶ but it is retained as a separate genus by Manton and Sledge⁷ on the ground that it differs consistently from *Athyrium* in having 41 as the base number whereas the base number in the latter genus is 40. The presence of $n = 41$ in *Diplazium* (cf. Manton and Sledge⁷) and *Diplaziopsis* (this report) proves the close relationship of these two genera already established on morphological grounds and their distinctness from *Athyrium*.

I am indebted to Professor P. N. Mehra for his helpful criticism and encouragement, and to Mr. R. S. Pathania for the microphotograph.

Dept. of Botany, S. S. Bha.
Panjab University,
Amritsar, December 12, 1957.

1. Bower, F. O., *The Ferns*, Camb. Univ. Press, 1938, 3.
2. Christensen, C., *Filicinae* in Verdoorn's *Manual of Pteridology*, 1938, Hague.
3. Ching, R. C., *Sunyatsenia*, 1940, 5, 201-70.
4. Dickason, F. G., *Ohio Jour. Sci.*, 1946, 46, 73-141.
5. Copeland, E. B., *Genera Filicum*, Waltham, Mass. U.S.A., 1947.
6. Holttum, R. E., *Biological Review*, 1949, 24, 267-96.
7. Manton, I. and Sledge, W. A., *Phil. Trans. Roy. Soc., London*, 1954, 238 B, 127-85.

REVIEWS

Advances in Nuclear Engineering, Vol. II. Coordinating Editors: John R. Dunning and Bruce R. Prentice. (Pergamon Press, Ltd., London W. 1), 1957. Pp. vii + 581. Price £ 7-7-0.

Volume II is the outcome of the Second Nuclear Engineering and Science Congress as Volume I. It comprises of 74 papers which in the main deal with Reactor Design, Metallurgical Instrumentation and other engineering problems in the field of reactor technology. The papers are presented under nine sections.

Section I deals under the title 'Reactor Design' the aspect of power generation with closed cycle gas turbines, the details of the Engineering Test Reactor at the National Reactor Testing Station in Idaho and Stress-corrosion cracking problems.

In Section II under reactor core design, two papers discuss the control systems employed in reactors. The control of a reactor is based upon introducing a material with good engineering properties having a high neutron capture cross-section. Relatively few elements are available for the purpose and these are Boron, Cadmium, Hafnium, Gadolinium, Samarium and Europium. The properties of these materials are discussed.

In Section III the operational problems met with in a homogeneous test reactor and a pressurised water reactor plant are discussed.

In Section IV under the title Educational Use of Reactors are described some low power reactors which can be installed in laboratories for instructional purposes. Two of the reactors dealt with are the small 5-watt laboratory reactor and a portable polyethylene-moderated training and research reactor.

In Section V which bears the title Metallurgy, 18 papers are presented under three subheadings: (1) Uranium Metallurgy and Radiation Effects, (2) Metallurgy of Reactor Materials, (3) Metallurgy of Uranium-Zirconium and Uranium-Niobium Alloys.

Zirconium base alloys, uranium and uranium alloys form the major portion of this Section. Corrosion resistance properties, transformation properties, effect of radiation on the physical properties of these materials are elaborately discussed in the papers. These are richly illustrated with microstructure photographs. A couple of papers deal with the aspects of mechanical properties of these alloys.

Section VI under the heading Natural Resources contains 8 papers on the mineralogical, geochemical and geological aspects of uranium bearing deposits and zirconium sources.

Section VII entitled Instrumentation is divided into three parts, namely, Reactor plant instrumentation, Reactor control and simulators and Reactor instrumentation development. Sixteen papers in all fall under these three headings.

In the general field of reactor instrumentation, four functions are to be fulfilled, viz., health safety, monitoring, control and the protection of nuclear reactors. Until the last three functions are fulfilled, the reactor cannot be safely used as either a neutron source or as a critical assembly. The first-named one is even more important from the health safety point of view of the operators. After these objectives are fulfilled, the programme is shifted to an experimental function. The papers presented deal with these aspects and the instrumentation part of some working reactors are discussed. The development of suitable electronic and electrical devices are also dealt with.

Section VIII deals with one of the most important engineering aspects of reactor technology, namely, Heat Transfer. The papers in this Section fall under three subdivisions again, viz., Primary Coolant Systems, Heat Transfer and Heat Evolution, and Problems Related to Heat Transfer.

In the last Section IX, preliminary consideration of standardization in the nuclear field and the need for it is discussed.

Volume II, as Volume I, is very well got-up and presents a wealth of information to engineers and metallurgists working in the field of reactor technology.

A. J.

Progress in Nuclear Physics, Vol. V. Edited by O. R. Frisch. (Pergamon Press), 1956. Pp. vii + 325. Price £ 4.00.

Volume V of *Progress in Nuclear Physics* contains a very readable collection of review articles dealing with fields of activity in nuclear physics which are all of topical interest. This volume maintains the high level set in the earlier issues. The articles are well written and have excellent bibliographies. The printing (both of text and diagrams) conforms to the usual excellent standards of Pergamon Press.

The one adverse criticism which must be levelled against this and some other members of the growing family of review journals is that the prices are so high that only libraries and perhaps a handful of research workers can afford to buy them. That these review journals are doing an excellent job and that they fulfil a real need and should therefore be available to the larger body of scientists is implicit in the above criticism.

The emphasis in this volume is slightly towards experiment. There are four articles which deal entirely with experimental methods and techniques. One, a comprehensive review, deals with organic scintillators. Another discusses new trends in electronic circuits used in nuclear physics research; the use of decimal counting tubes (dekatron, trochotrons and ribbon beam tubes) which make it possible to build scaling units without complex scaling circuits and electromechanical devices, are dealt with in this, as also transistorization of circuits. The article on the bubble chamber certainly gives one a feeling for this new tool, which probably has had as much of an impact on the development of particle physics as the nuclear research emulsion. The importance of a technique of this description as visualized by its inventor, Glaser, and the principles underlying its operation are well brought out. It is unlikely that any revolutionary developments will now take place in this technique; the trend is to build "bigger and better" chambers. For a long time to come therefore, this article will be of use to non-specialists as an introduction to this field. The other experimental article is on the accurate determination of nuclear reaction energies.

There are three theoretical surveys. The article on the neutrino is of particular interest. It is well written and gives the experimental evidence for the neutrino and the theoretical position as existed in early 1956. The discovery of free neutrinos apparently rounded off the subject. No indication was available then of the tremendous change that was to come over the whole field of β -ray phenomena (and concerning the neutrino in particular) as a result of the discovery of non-conservation of parity in weak interactions. The word parity is used in this survey only with reference to the Gamow, Teller and Fermi selection rules. Even in the present situation, most of the article stands unchanged and serves as a good introduction to the earlier work. The other two theoretical articles deal with the inelastic scattering of fast neutrons and with

nuclear size. A considerable amount of work has been done in both fields in the past few years. Two completely new electrical methods have been used to determine nuclear radii. Both yield a value $r_0 = 1.2 \times 10^{-13}$ cm.; r_0 is a constant in the equation for the nuclear radius, $R = r_0 A^{1/3}$, (A being the number of nucleons in the nucleus). About four years ago r_0 was believed to be $\sim 1.46 \times 10^{-13}$ cm. A discussion of the concept of nuclear size as determined by different methods shows that there is consistency amongst the various values.

The majority of articles in this and in previous volumes of this journal have been written by scientists from the U.K. Atomic Energy Research Establishment, Harwell. This is an indication of the trend to shift nuclear physics from Universities and concentrate it at Harwell.

M. G. K. MENON.

Phenazines. By G. A. Swan and D. G. I. Felton. (Interscience Publishers, New York), 1957. Pp. xix + 693. Price \$22.50.

The eleventh volume of the *Chemistry of Heterocyclic Compounds* in the series edited by Weissberger consists of two parts; the first covers phenazines and their quaternary salts, and the second deals with compounds in which carbocyclic or heterocyclic rings are fused to the phenazine nucleus. General methods for the synthesis of phenazine and its derivatives are outlined in Chapter I. Homologues, hydrogenated derivatives, and substitution products are listed and treated briefly in the succeeding chapters. The Safranines, Indulines, Nigrosines, Aniline Black and Indanthrone have received adequate attention in other books and might well have been omitted from the present volume. The statement (p. 163) that Willstätter's view of the structure of Aniline Black is incorrect may be contrasted with Sir Robert Robinson's appraisal of Willstätter's work on Aniline Black (*J. Chem. Soc.*, 1953, 1008). The Addenda contain an uncritical abstract of Wyman's interpretation of the infrared spectrum of indanthrone; the structure proposed by Wyman for indanthrone is open to several serious objections. The chapters on bacterial pigments and the biological properties of phenazines are well written and constitute a valuable part of the book; the more recent and important work of Barry on the phenazine pigments obtained by oxidation of 2-aminodiphenylamine derivatives and their antitubercular activity (*J. Chem. Soc.*, 1956, 888; *Ibid.*, 3347) has been included in the Addenda, but

a further reference may be added (*J. Pharm. & Pharmacol.*, 1956, 8, 1089). Barry's note on a new series of phenazines ("rimino-compounds") with high antitubercular activity (*Nature*, 1957, 179, 1013) appeared too late for inclusion.

Chapter XII has sections on 5:12-diazanaphthacene and its derivatives, although these have been treated in C. F. H. Allen's volume in the same series. The main part of this chapter and the next two chapters give a very useful and comprehensive account of benzo[a]phenazine and its derivatives. Polybenzophenazines are similarly covered in the next two chapters. The two concluding chapters compile information on phenazines condensed with heterocyclic systems. An error in Allen's book (p. 39) has been corrected, but there is no reference to the paper in which the Wohl-Aue reaction between 1-naphthylamine and 2-nitroaniline was correctly interpreted (Cook and Hunter, *J. Chem. Soc.*, 1953, 4183).

The literature has been covered conscientiously and thoroughly, and the result is a very useful book of reference. The general impression one has is that material available in Beilstein and Chemical Abstracts has been collected and classified. Critical comments have been made on many reactions, and attention has been drawn to likely errors in the older literature, but more space could profitably have been devoted to the interpretation of data and the discussion of reaction mechanisms.

The production is lavish; larger letters, wider spacing, and better paper than in some of the other volumes of the series have been used.

K. V.

The Harvey Lectures, 1955-56. Series LI. (Academic Press, Inc., New York; Asia Publishing House, Bombay-1), 1957. Pp. xv + 298. Price \$8.00.

The diffusion of scientific knowledge in selected chapters of anatomy, physiology, pathology, bacteriology, pharmacology and physiology—the main object of the Harvey Society Lectures—has been amply fulfilled by the presentation of this volume. Main features of these lectures are outlined below:

Eccles by examining in detail the relationship of excitatory post-synaptic potential (EPSP) as recorded intracellularly to the generation of impulses by the motoneurone and the inhibitory post-synaptic potential (IPSP) has given an account of the mechanisms involved in these fundamental reactions of the nervous system.

In "Nucleic Acids and Protein Synthesis", Dr. Gale deals with experiments carried out by his group with sonic extracts of staphylococci to elucidate the template theory of protein synthesis and with their success in separating a number of "amino acid incorporation factors" from ribonuclease digests of RNA.

Dr. I. F. Fruton in his lecture on "Enzyme Hydrolysis and Synthesis of Peptide Bonds" has shown that transamidation in which proteinases take part, is more significant in protein synthesis than their hydrolytic property and suggests that acyl proteinases are intermediates in protein synthesis.

In "The Chemistry of Mesodermal Ground Substances", Dr. Karl Meyer discusses the occurrence, properties and biosynthesis of the various acid mucopolysaccharides of the connective tissue. Some experiments with chondroitin sulphate on wound healing, blocked by cortisone application have been described. The structure of chondroitin sulphate B bears striking resemblance to L-ascorbic acid and may be derived from it.

Dr. E. Racker in a brilliant article reviews the work on the "Micro- and Macrocycles in Carbohydrate Metabolism" and describes their attempts at reconstruction of the cycles carried out with pure enzymes as also the occurrence of yet another cycle in yeasts and ascites tumour cells involving octulose-8 phosphate.

Ranmekamp's studies on the biological changes of group A streptococcus during its residence in the upper respiratory tract has led him to conclude that the carrier is less likely to transmit the disease and that environmental reservoirs are not important in the maintenance of the organism in nature or in the production of the disease.

By a critical analysis of the pathogenesis of rheumatic fever and the role of humoral bodies in the production of nephritis, the author concludes that multiple closely spaced infections, age, serological typing, season or inherited susceptibility are not the major contributory causes for those complications and that primarily attention should be focussed on the biological changes induced in the organism.

Keith Porter with the aid of electron microscope, has discussed about the form and function of cells at macromolecular level and on the special arrangement of biological material on the protoplasm. The existence of an 'elastic framework' "Endoplasmic reticulum" has been unequivocally demonstrated. Structural correlation between this reticulum and the nuclear

membrane and relationship of this system with the microsomal fraction has been postulated.

In "Bacteriophage T_2 —A Parasite or Organelle", Hershey puts forth a novel view of viral infection utilising Bacteriophage T_2 , labelled in their protein with radio sulfate and the nucleic acid with radiophosphate, as also carrying out quantitative precursor relationships between nucleic acid and protein synthesis by utilising specific inhibitors. He considers that phage precursor DNA is not formed inside phage precursor protein membranes and DNA made in the absence of viral protein synthesis is normally functional.

In a little known subject of limitless potentialities, "The Chemistry and Physiology of Bioluminescence", McElroy describes the influence of oxygen, luciferin, A.T.P., CoA and Mg^{++} on firefly luminescence and the mechanism and control of the firefly flash by luciferase.

M. SIMS.

The Electrophysiology of the Heart. (*Annals of the New York Academy of Sciences*, Vol. 65, Art. 6, pp. 653-1146), 1957. Price \$4.50.

This monograph is the result of a Conference on the Electrophysiology of the Heart held in February 1956, and supported in part by the New York Academy of Sciences.

Several of the world's best known authorities on the subject have taken part in this Symposium.

Part 1 of the Monograph deals with cellular events during the cardiac cycle.

A large number of observations on electrical measurements, chemical analysis, isotope-tracer studies and model analogues have now been accumulated and this has laid the groundwork for an interpretation of the nature of an excitable cell and its mode of action. Those properties reported for nerve and skeletal muscle have been thought in a large measure to apply to cardiac muscle as well. The obvious differences in automatism, speed of response and length of recovery that characterise cardiac tissue have posed a number of questions although no one denies that a fundamental similarity exists between all excitable tissues.

Part 2 deals with the spread of impulses through cardiac muscle. One paper in this part describes the instrumental set-up suited for the purpose of introducing electrodes into the ventricular valves and septum in such a way as to cause only minimal injury, and not alter the response of the cardiac muscle fibres

to the excitation process and also describes the experiments that have been carried out with intramural leads in dogs as well as in goats. At the end of this chapter is a report, perhaps the only one in the whole book that the clinician will find easy to read, of a panel discussion on 'anomalous atrioventricular excitation' which is a more descriptive term for the Wolff-Parkinson-White syndrome.

In Part 3 the recovery process in cardiac muscle is discussed in several papers. Holter has described the new technique of radio-electro-cardiography for the study of cardiovascular activity. There is a panel discussion on the 'U' wave and after-potentials in cardiac muscles.

In Part 4 are considered the results of the fact that the heart like all living cells of the body except those in the skin lies within a volume conductor. The characteristic features of the human volume conductor which make it so difficult to obtain uniform results in the hands of different workers have been discussed.

In the last part, the inaccurate assumptions that have so far been made in conventional electrocardiography and the improvements that may be possible are discussed.

The thorough understanding of the monograph will require a knowledge of physics with special reference to electricity that is not always found in most clinical workers. Even so the physician interested in cardiology will be able to learn a great deal from this rather tough monograph.

K. S. S.

Proceedings of the Third Weed Control Conference, Vols. I and II. (Published by British Weed Control Council, Cecil Chambers, 86 Strand, London, W.C. 2), 1956. Pp. xiv + 870. Price 2 Guineas.

The menace of weeds in cultivation and of their robbing the crop plants of nutrition and space besides contaminating the agricultural produce, has been a problem facing the farmers of the world for centuries. As a result, since centuries past considerable effort had to be expended in human labour and at much cost to keep weeds in check. The fight against weeds, until the past few decades, has been long and drawn out and the weapons used have been simple with limited effects. About the turn of the century, however, the use of chemicals to suppress weeds helped to raise the sagging hopes of farmers who were hard hit by periods of depression although the wonder chemicals so familiar to us now were still in

the offing. Calcium cyanamide, copper sulphate, sodium chlorate, sulphuric acid, were some of the precursors of more effective chemical weed-killers that were to follow. In the battle against weeds, the harnessing of organic compounds opened up a new and vast field as these offered the advantage of providing an extensive series of chemicals that were varying in effect, depending on their constitution. The discovery of growth-promoting substances and the study of their effect on plant growth combined with the stress of the Second World War made possible the revolution in weed control, which led to the findings of the herbicidal properties of substances of hormone type. MCPA and 2, 4-D blazed the trail in 1945 and since then their variants and numerous other chemicals have been pressed into service in the war against weeds.

The two volumes of the *Proceedings of the Third British Weed Control Conference* held in 1956, under review, are an impressive record of the achievements in the battle against weeds. The discussions cover a very wide range of topics such as weed-killers in relation to efficient food production, factors influencing acceptance of new techniques by farmers, weed control equipment, weed ecology, chemical weedicides, such as the Dinitrophenols and Phenoxybutyric groups, application techniques, crop desiccation, eradication of weeds such as wild oats, *Juncus* sp., annual and perennial grass feeds, Braken, rush, etc., application of herbicides to control weeds in crops such as cereals, forage legumes, peas, vegetable and fruit crops and in forest nurseries, besides the consideration of more important aspects such as those of development of resistance or tolerance to herbicides and the effect of weedicides on animal life.

The discovery of herbicides of hormonal type have not only solved but have created attendant problems such as that of 'spray drift' which can cause damage to crops at considerable distance, injury to main crops, economics of application, differential varietal responses of a crop to the same dose of same weed-killer, etc.

It is difficult to single out any of the papers as more important as most of them furnish information of some importance or other. In his paper, Sir John Russel makes a wide survey of the problem of control of weeds in relation to efficient food production and points out that even with all the modern techniques that would be brought into play including the possibility of automation invading the garden and the

farm, "the husband man's path will always be beset with troubles".

The perusal of the papers included in the two volumes of the proceedings shows that the chemical control of weeds is not an easy and a straightforward method as it was thought at first but that it is highly complex as it leaves a number of attendant problems unsolved. As expressed by one of the contributors to the proceedings, "Altogether a great deal of research is required if we are to develop these new chemicals so that they can be of greatest use to the agricultural industry in this country." Even though this remark is meant for Britain it is equally applicable to any other country. There is no doubt that in future weeds will be controlled more and more by chemical methods but there yet remains much to be done to reduce the methods into common standard practices which could be adopted by farmers with confidence.

The two volumes contain a great deal of information which not only will interest but would be found useful to workers in the field of weed control.

L. S. S. KUMAR.

Plant Virus Serology. By R. E. F. Matthews. (Cambridge University Press), 1957.

Pp. 1-128. Price 27 sh. 6 d. net.

The book is rightly described as a descriptive survey of experimental methods for serologists with practical instructions. With a large expansion of acreage of clonally propagated crops in India such as potatoes, sugarcane and fruit trees like apple, peaches, etc., the need for certification of seed stock against virus diseases is becoming very important. Serological methods developed for medical research have been used for detecting plant viruses in seed stocks on a commercial scale. The need for a book giving all details of methods of handling serological studies of plant viruses has always been felt by the plant pathologists and the present book by Dr. Matthews has amply fulfilled the requirement. The book is divided into 11 chapters, each chapter giving details of the procedures. Starting from the methods of preparation of viruses and antisera and the types of serological tests, details are given for the routine testing of virus infection. Chapter 5 deals with serological tests for determining relationships among plant viruses. The list of viruses which have given negative results in serological tests are listed on page 42. To the list of 18 viruses given by the author, several more may be added from published

papers which indicate that while serological tests are aids in detecting viruses and their relationships, they are not always absolute. Chapter 6 deals with various aspects of precipitation reaction used for detecting virus relationships. Methods of determination of titres of antibodies in the serum and methods for estimating virus concentration are outlined in Chapters 7 and 8. Cross-absorption procedure and precipitation in mixed systems are outlined in Chapters 9 and 10. In the last chapter on the applicability of serological techniques, the author enumerates possible causes of failure to obtain positive serological tests. He states that there are 170 other viruses to which this method has not been applied. Some very valuable suggestions are made for obtaining positive serological tests. Even though the book deals chiefly with plant viruses, the details of the subject treated are so lucid and practical, that it would be of immense value to all workers researching into serology, including students of medicine.

M. J. N.

Books Received

- The Chemistry of Natural Products, Vol. I. (The Alkaloids.)* By K. W. Bentley. (Interscience Publishers, New York; India: Asia Publishing House, Bombay-1), 1957. Pp. vii + 237. Price \$ 4.00.
- Report of the Symposium on Magnetism, 1954.* (Indian Association for Cultivation of Science, Calcutta-32), 1957. Pp. vi + 232. Price Rs. 7.
- New Frontiers of Knowledge—A Symposium by Distinguished Writers, Scholars and Public Figures.* (Public Affairs Press, 419, New Jersey Ave, Washington-3, D.C.), 1957. Pp. x + 125. Price \$ 2.75.
- Pioneering in Industrial Research—The Story of the General Electric Research Laboratory.* By Kendall Birr. (Public Affairs Press, Washington-3, D.C.), 1957. Pp. vii + 204. Price \$ 4.50.
- Physics in Industry—Pressure Measurement in Vacuum Systems.* By J. H. Leck. (Chapman & Hall, London, for The Institute of Physics, 47, Belgrade Square, London, S.W.1), 1957. Pp. 144. Price 30 sh.
- Tracer Applications for the Study of Organic Reactions.* By John G. Burr Jr. (Interscience Publishers, New York.) Pp. x + 291. Price \$ 7.50.
- Control of the Plant Environment.* Edited by J. P. Hudson. (Academic Press, New York 1, N.Y.), 1957. Pp. xvi + 240. Price 42 sh.
- Yeasts.* Edited by W. Roman. (Dr. W. Junk Pub., The Hague, Netherlands, 13, Van Stolkweg), 1957. Pp. 246. Price 25 guilders.
- Hormones, Brain Function and Behaviour.* Edited by Hudson Hoagland. (Academic Press Inc., New York; India: Asia Publishing House, Bombay-1), 1957. Pp. 257. Price \$ 7.00.
- The Grassland and Fodder Resources of India.* By R. O. Whyte. (The Indian Council of Agricultural Research, Queen Victoria Road, New Delhi), 1957. Pp. iii + 437. Price Rs. 14.
- Interscience Monographs in Physics and Astronomy, Vol. I. (The Fundamental Constants of Physics.)* By E. R. Cohen, K. M. Crowe and J. W. M. Dumond. (Interscience Publishers, New York), 1957. Pp. xii + 287. Price \$ 7.50.
- Pure and Applied Mathematics, Vol. IV. (Water Waves.)* By J. J. Stoker. (Interscience Publishers, New York.) Pp. xxviii + 567. Price \$ 12.00.
- Advances in Enzymology and Related Subjects of Biochemistry, Vol. XIX.* Edited by F. F. Nord. (Interscience Publishers, New York; India: Asia Publishing House, Bombay-1), 1958. Pp. v + 457. Price \$ 9.85.
- Flame Photometry—A Manual of Methods and Applications.* By F. Burriel Marti, J. Ramirez Munoz. (Elsevier Pub. Co., 31, Wright Lane, London W.8), 1958. Pp. xii + 531. Price 65 sh.
- The Measurement of Colour.* By W. D. Wright. (Hilger & Watts Ltd., London N.W. 1), 1958. Pp. ix + 263. Price 52 sh.
- Encyclopedia of Chemical Technology.* Edited by Raymond E. Kirk and Donald F. Othmer. (Interscience Publishers, New York 1; India: Asia Publishing House, Bombay-1), 1958. Pp. xviii + 974. Price \$ 25.00.
- Structure Reports for 1951, Vol. 15.* Edited by A. J. C. Wilson. (N. V. A. Oosthoek's, Dordrecht, Utrecht), 1958. Pp. viii + 588. Price \$ 29.
- Chronica Botanica, Vol. 17. (The Experimental Control of Plant Growth.)* By Frits W. Went. (The Ronald Press Co., New York 10, N.Y.), 1958. Pp. xvii + 343. Price \$ 8.50.

SCIENCE NOTES AND NEWS

New Standard of Length

The Advisory Committee for the Definition of the Metre, headed by L. E. Howlett, Director of the Division of Applied Physics, National Research Council of Canada, has unanimously agreed on a new standard of length—a wavelength of light—to be used instead of the platinum-iridium bar kept at Sevres, France. The leading contenders as the source for light for the standard have been the following isotopes: mercury-198, krypton-84, krypton-86 and cadmium-114. One of the wavelengths of orange light emitted by krypton-86 has been selected as the standard, and the international meter will be defined as 1,650,763.75 times this wavelength. The resulting standard will be more than 100 times as precise as the present international meter.

Although in practice the new standard is already in use, several steps remain before the wavelength becomes officially recognised. The Committee mentioned above will send its recommendation to the International Committee of Weights and Measurements for consideration at its Meeting in October 1958; when approved there, the recommendation will be presented to the International Conference on Weights and Measures, which will meet in 1960; at that time the standard will become the legal international standard. (*Science*, Jan. 1958.)

Using Free Radicals

Ordinarily, free radicals exist only for very short periods in systems such as flames, electric arcs and hot gases.

Numerous methods have however been developed for capturing and storing them mainly at low temperatures. N.B.S. workers have frozen the products of an electric discharge at a few degrees absolute, capturing some types of free radicals in highly excited states and making it possible to study them, including analysing them spectroscopically. This opens a whole new field of low temperature chemical kinetics which, in principle, offers prospects for a very significant effect on industrial chemical processes. It is hoped that with free radical stabilization processes, it may be possible to synthesize new materials, to improve the yield in the synthesis of materials that have been pro-

duced in other ways, and perhaps even to provide better control over various industrial processes. However, the work is still at an early stage and the details of the mechanisms by which the results may be achieved have yet to be discovered.

Corrosion and Chemistry

The above theme will be discussed at the Second Congress of the European Federation of Corrosion which will take place in Frankfurt (Main) from 5th to 8th June 1958 within the framework of the European Congress of Chemical Engineering, 1958. Forty-eight technical and scientific societies in 15 countries are members of the European Federation of Corrosion.

Corrosion is of particular importance in chemical technology because many of the materials handled in this branch of industry are characterized by their extremely aggressive properties. The high temperatures which are frequently employed also favour corrosion. For this reason a large number of special structural materials have been developed for use in the chemical industry and many processes have been devised for the protection of the surface of materials of construction.

Protection from corrosion is also within the province of the chemist. Apart from the possibilities of special types of construction used to prevent damage, the chemist is often able to combat corrosion by producing new structural materials and protective surface coatings. He is also able to devise methods of testing and measurement which can be used for determining the rate of destructive processes by standardized techniques, with a view to selecting the most suitable type of protection from corrosion.

This field, which is of such economic and scientific importance, will be covered by 6 plenary lectures and 48 papers, followed by discussions which will be presented by representatives from 12 countries from 5th to 7th June 1958.

The programme and an invitation to take part in the Congress may be obtained free of charge from the Congress Business Office: Gesellschaft Deutscher Chemiker, Frankfurt (Main) Haus der Chemie, Karlstr. 21.

Lysine Supplemented White Rice

The improvement in nutritive quality of the protein of a food or feed, attainable by amino acid supplementation, is dependent upon many factors. These include the recognition of the essential amino acid requirement of the species or individual which is to benefit from the improved protein and the amino acid composition of the food to be improved. Application of these sound principles has been rewarding in several instances.

The nutritive value of the protein of white polished rice can be improved significantly by supplementation in the first limiting amino acid, lysine in amounts sufficient to bring this amino acid in balance with the second limiting amino acid. Growth responses in rats fed with lysine supplemented rice were found to be very satisfactory (*Jour. Nutrition*, Vol 63, 1958, 477).

Spotted Wilt Disease

Spotted wilt is a virus disease which attacks plants most seriously during the spring, summer and autumn. Young, vigorously growing annuals are often rapidly killed or so severely stunted that they become worthless. On the other hand, perennials may tolerate the disease to greater or less extent, some being stunted and of poor vigour while others show little or no effect.

Plants which are known to be attacked by the virus include amaryllis, anemone, arum lily, aster, calceolaria, calendula (marigold), Canterbury bell, chrysanthemum, cineraria, dahlia, gailardia, gerbera, happeastrum, Iceland poppy, *Lilium* spp., nasturtium, petunia, phlox, salpiglossis, schizanthus, snapdragon, sweet pea, veronica and zinnia. The disease also occurs in lettuce, potato, tobacco and tomato and a large number of weeds.

Diseased plants can mostly be recognised by abnormalities which develop in the leaves, although the symptoms vary according to the kind of plant affected.

The spotted wilt virus loses its infective powers very rapidly when plant tissue, in which it is growing, is injured. As a result

it is seldom, if ever, transferred from a diseased to a healthy plant during pruning or other cultivation methods in the field. It is also quite common to find a healthy plant such as a tomato, growing intertwined with one severely affected with spotted wilt.

All available evidence suggests that the only means by which this disease spreads naturally is when it is carried by a small insect, the thrip.

The virus enters the thrip when it is feeding on infected plants and, if the thrip has not yet reached its adult stage, the virus remains alive and possibly multiplies in its insect carrier. So far as is known the thrip is not inconvenienced in any way but retains its power to inoculate plants throughout its subsequent adult life.

Any plants known to be infected should be destroyed and insecticides should be used at frequent intervals in an endeavour to keep the population of thrips at the lowest possible level (*Agri. Gaz. of N.S.W.*, Jan. 1958, 69, 33).

Sir Dorabji Tata Gold Medal (Third Award)

The Third Award of the Sir Dorabji Tata Gold Medal of the Zoological Society of India will be made for the best research work in any branch of Zoology, published during the three-year period 1955, 1956 and 1957.

As it is not possible for the Society to compile a list of Zoological publications of all workers in India, the authors are requested to send one copy of each of their publications during the period 1955-57, to enable the Selection Committee to make a suitable choice. The reprints will be kept in the library of the Society.

Reprints should be sent so as to reach Prof. M. L. Roonwal, President, Zoological Society of India, 34, Chittaranjan Avenue, Calcutta-12, before the 30th of June 1958.

CORRECTION

Vol. 27, No. 1, p. 23, note on "Pyrolysis and Ignition of Wood", the figure in column 3 of Table I should read 228° C. instead of 288° C.

384-58. Printed at The Bangalore Press, Bangalore City, by C. Vasudeva Rao, Superintendent, and Published by A. V. Telang, M.A., for the Current Science Association, Bangalore.

All material intended for publication and books for review should be addressed to the Editor, *Current Science*, Raman Research Institute, Bangalore-6.

Business correspondence, remittances, subscriptions, advertisements, exchange journals, etc., should be addressed to the Manager, Current Science Association, Raman Research Institute, Bangalore-6.

ANNUAL SUBSCRIPTION

India: Rs. 8-00.

Foreign: £ 0-16-0. \$ 2.50.

OMEGA INSTRUMENTS CO. CALCUTTA

Manufacture—

LABORATORY OVENS with thermostatic control of all sizes for various temperature ranges, with and without fan circulation.

THERMOSTATIC BATHS

NULL POINT DETECTOR

LABORATORY OSCILLATOR

LABORATORY CIRCULATION PUMPS

SERUM INSPISSATORS

INCUBATORS

PILOT PLANTS FOR INDUSTRY

Please send enquiries to the Sole Selling Agents

KINLAB (PRIVATE) LTD.

**5, Marquis Street
CALCUTTA 16**

SPECTROSCOPIC EQUIPMENT AND ACCESSORIES

FOR

QUANTITATIVE ANALYSIS & RESEARCH WORK

Light sources like Arc Lamps with universal movements, precision slits, mountings for spectrographs, cameras, microphotometers, etc., etc.

Entirely Our Manufacture

For full particulars, please write to :

**THE GENERAL
ENGINEERING AND SCIENTIFIC CO.**

**WALTAIR, VISAKHAPATNAM-3
(S. INDIA)**

GRAMS: "ELECTRONIC"

Technical Adviser :

**Dr. I. RAMAKRISHNA RAO
M.A., Ph.D. (Cal.), D.Sc. (Lond.)**

BALANCES

FOR

RESEARCH & ROUTINE WORK



Catalogues sent on request

Manufactured by :


SCIENTIFIC INDUSTRIES (India)

34, Banerji Bagan Lane, SALKIA (Howrah)

All In One
INDEX
 REAGENT BOTTLES
Made by
Sigeeol



Sole Distributors
GHPURE & CO.
 P36, ROYAL EXCHANGE PLACE
 EXTENSION - CALCUTTA-1
 GRAM-MEENAM PHONE-222061



KEROY
 Short Beam
 Analytical
 Balance

No. K 1

A Really Dependable Balance for Degree
 Classes and Research Laboratories

Sensitiveness .. 1/10th mg.
 Capacity .. 200 gm.

Fitted on 5/8" thick glass base Price: Rs. 325/-
 Catalogue on Request

Manufactured by:
Keroy (Private) Ltd.
 BANARAS CANTT. :: CALCUTTA 10
 "Calcutta Telephone No. Is 24-3840."

**VERY RELIABLE INDIGENOUS SUBSTITUTES
 OF GUARANTEED ANALYTICAL REAGENTS
 MAY BE FOUND IN**

"BASYNTH"

**Brand
 ANALYTICAL REAGENT**



Acid Hydrochloric
 Acid Hydrochloric Fuming
 Acid Sulphuric
 Acid Nitric
 Acid Nitric Fuming
 Acid Acetic Glacial
 Ammonium Hydroxide
 Benzene
 Toluene
 Xylene
 Petroleum Ether
 Amyl Alcohol
 Butyl Alcohol Etc., Etc.

Basic & Synthetic Chemicals (Private) Ltd.
 P. O. Jadavpur College, Calcutta-32

**MOST RELIABLE INDIGENOUS SUBSTITUTES OF
 GUARANTEED ANALYTICAL REAGENTS
 MAY BE FOUND IN**

OSTER

Brand

ANALYTICAL REAGENTS

- ACID HYDROCHLORIC
- AMMONIUM HYDROXIDE
- ACID NITRIC
- ACID SULPHURIC
- LABORATORY CHEMICALS

**Oster Chemical & Pharmaceutical
 Works (Private) Ltd.**

Regd. Office:

78 B, Manicktala Street, CALCUTTA-5

Works:

225, Bagmari Road, CALCUTTA-11

TELEPHONE: 38-2052

We offer our Services for G. R. quality acids with guaranteed test reports as follows:—

Acid Hydrochloric, A.R. S.G.

1·16 & 1·18-9

Container.....	Resistant Glass	
Non-Volatile matter ..	0·0015%	
Iron ..	0·0001%	
Sulphate ..	0·0003%	
Free Chlorine ..	0·0002%	
Arsenic ..	0·000004%	
Heavy Metal (as Pb) ..	0·0002%	

Acid Nitric, A.R. S.G. 1·42

Container.....	Resistant Glass	
Non-Volatile matter ..	0·001%	
Sulphate ..	0·0003%	
Chloride ..	0·0001%	
Iron ..	0·0001%	
Arsenic ..	0·000005%	
Heavy Metal (as Pb) ..	0·0002%	

LUCKY ACID & CHEMICAL WORKS


32/2, Muraripukur Road, CALCUTTA-4

22-5009

INSIST ON

M BRAND

MEGHINDUS



Laboratory

PORCELAIN-WARES

DEPENDABLE — DURABLE

MEGHNA

INDUSTRIES PRIVATE LIMITED
12 CANNING ST. CALCUTTA 1

JOURNAL OF SCIENTIFIC & INDUSTRIAL RESEARCH

REVISION OF ADVERTISEMENT AND SUBSCRIPTION RATES

with effect from January 1958

REVISED ADVERTISEMENT RATES*

INSERTION	FULL PAGE	HALF PAGE	QUARTER PAGE
Twelve	Rs. 700·00	Rs. 400·00	Rs. 250·00
Six	Rs. 400·00	Rs. 250·00	Rs. 150·00
Single	Rs. 80·00	Rs. 50·00	Rs. 30·00
2nd and 3rd cover pages and pages facing reading matter			Rs. 800·00 each.
Fourth cover page			Rs. 1,000·00

* The revision will not affect existing contracts and will take effect after the expiry of the contracted period.

REVISED SUBSCRIPTION RATES

ANNUAL SUBSCRIPTION:	Inland Rs. 20·00;	Foreign £ 2 or \$ 6·00
PRICE PER ISSUE:	Inland Rs. 2·00;	Foreign Sh. 4 or \$ 0·60

For particulars write to:

UNDER-SECRETARY, PUBLICATIONS DIRECTORATE

COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH

OLD MILL ROAD

NEW DELHI 2

INJECTABLES — Safe and Dependable



A wide range of parenteral preparations for meeting the growing requirements of the Medical Profession are now being processed in our Laboratories. They are made from Standard Chemicals employing double distilled and PYROGEN FREE water. Their containers (Ampoules) undergo rigid neutrality tests before they are selected for use. These Injectables are therefore guaranteed to be absolutely safe and dependable.

The following are but a few of our well-known Injectables :

● RETICULIN	A Potent extract of Liver
● HEXOPURIN	An urinary Antiseptic
● CALCITOL	Injectable Calcium Gluconate
● BEVITAMIN	" Vitamin B ₁
● CEVITAMIN	" Vitamin C
● GLUCOSE SOLN.	" Pure Dextrose

The Mysore Industrial & Testing Laboratory Ltd.

Malleswaram P.O., Bangalore 3

Bengal Chemical and Pharmaceutical Works, Ltd.

The Largest Chemical Works in India

Manufacturers of Pharmaceutical Drugs, Indigenous Medicines, Perfumery, Toilet and Medicinal Soaps, Surgical Dressings, Sera and Vaccines, Disinfectants, Tar Products, Road Dressing Materials, etc.

Ether, Mineral Acids, Ammonia, Alum, Ferro-Alum, Aluminium Sulphate, Sulphate of Magnesium, Ferri Sulph., Caffeine and various other Pharmaceutical and Research Chemicals.

Surgical sterilizers, Distilled Water Stills, Operation Tables, Instrument Cabinets and other Hospital Accessories.

Chemical Balance, Scientific Apparatus for Laboratories and Schools and Colleges, Gas and Water Cocks for Laboratory use, Gas Plants, Laboratory Furniture and Fittings.

Fire Extinguishers, Printing Inks.

Office: **6, GANESH CHUNDER AVENUE, CALCUTTA-13**

Factories: **CALCUTTA - BOMBAY - KANPUR**

Gallenkamp *New Development*

Gallenkamp Ebulliometer

HEITLER PATTERN



Molecular Weights a quick new way

Designed in co-operation with Mr. C. Heitler of Northampton College
of Advanced Technology (London)

- ◆ Determinations in 10 minutes
- ◆ Accuracy 1% with 0.2 g. samples
- ◆ Rapidly reaches equilibrium (< 3 minutes)
- ◆ Thermistor sensing for rapid response and high sensitivity
- ◆ Borosilicate glass parts
- ◆ Additional Equipment not required
- ◆ Simple to use
- ◆ Quickly saves its own cost in time gained

Manufactured by

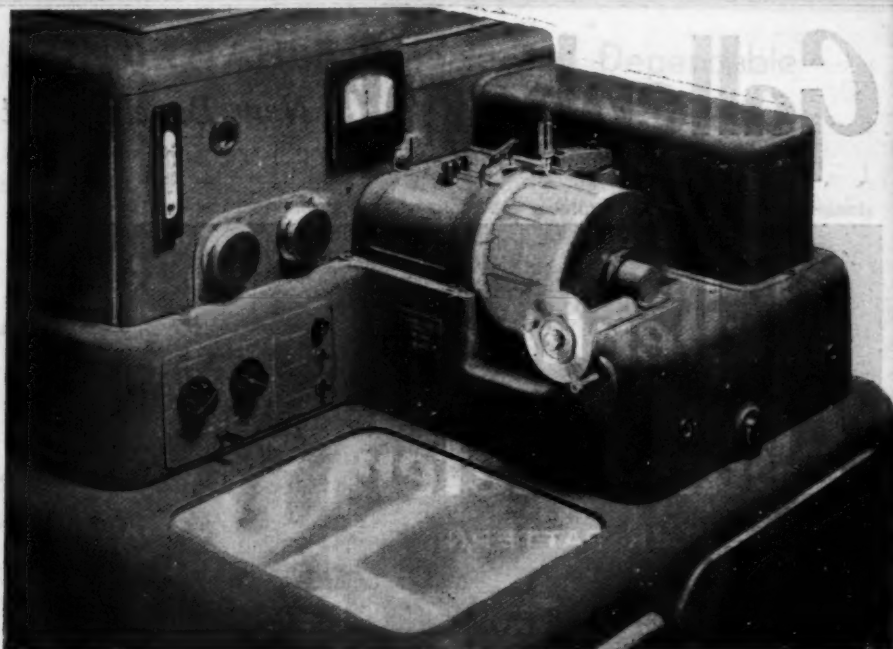
A. GALLENKAMP & CO. LTD., London, England

Accredited Agents

MARTIN & HARRIS (PRIVATE) LIMITED

(SCIENTIFIC DEPARTMENT)

Savoy Chambers, Vallace Street, Bombay-1



Leitz

INFRARED SPECTROGRAPH

An Essential Equipment for Higher Research

Spacious and stable design, convenient and clear arrangement of all electronic equipment for safe and reliable operation, easy interchangeability of the various parts, three-fold extension of the wavelength scale, control of recording speed, automatic switch off of recording mechanism, rapid adjustment of the recording drum, simple and rapid setting of the wavelength range, simple change-over to single-beam operation, recording of processes in reaction kinetics, measurements in visible spectrum after switching off the recording mechanism, etc., are some of the outstanding features which strongly recommend it as one of the best instruments of its kind.

Sole Distributors

THE SCIENTIFIC INSTRUMENT COMPANY LTD.

ALLAHABAD BOMBAY CALCUTTA MADRAS NEW DELHI

nic
ts,
tic
nd
on,
ter
res

D.
-H